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AUTOMATED PROCEDURE FOR EVALUATING SITES FOR SUITABILITY AS HELICOPTER LANDING ZONES

Volume I

DESCRIPTIONS AND INSTRUCTIONS FOR USE OF COMPUTER PROGRAMS

by

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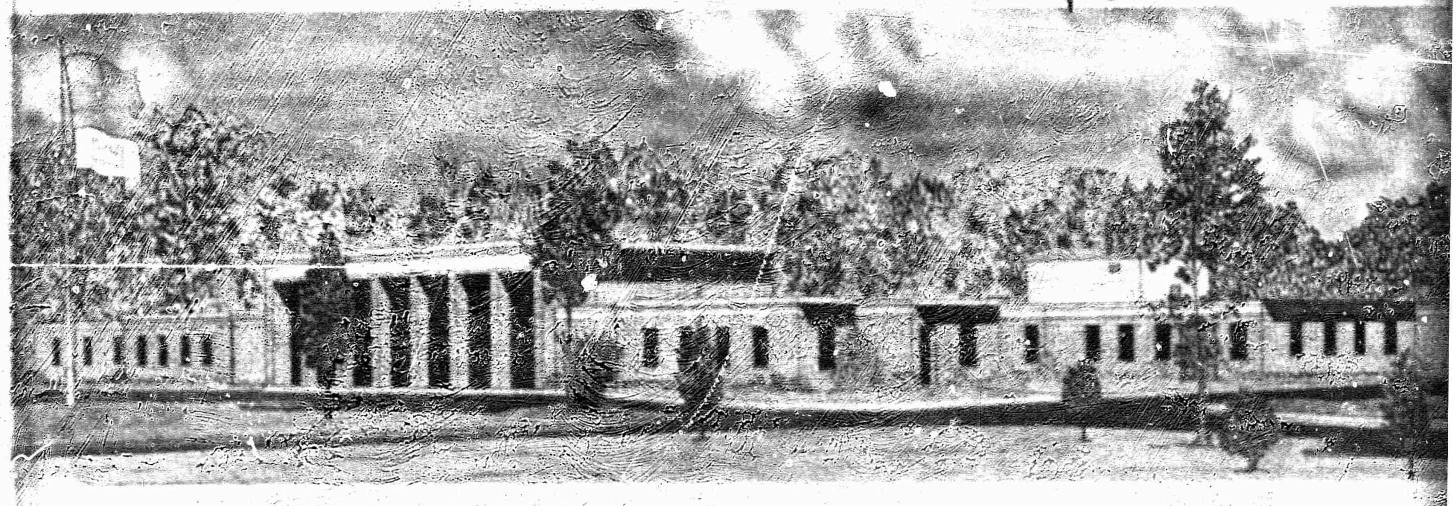

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This report contains instructions for operating a model that is an automated procedure for evaluating designated sites as helicopter landing zones. The model is comprised of three independent computer programs run sequentially.

Program 1 (FTHEL) evaluates the site in terms of generalized conditions

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of slope, microrelief, and soil strength as related to the requirements set by certain characteristics of the helicopter that is to land. The program determines whether the site can provide a full-touch zone, a skid-touch zone, a nontouch zone, or no landing zone at all, and computes the minimum departure angle for the specified helicopter if a landing zone is possible.

Program 2 (FTJPRH) is an automated mathematical procedure for predicting the size and shape of a clearing in a forested area by considering blast forces from a bomb explosion, tree stem strength, stem diameter, and distance from ground zero (GZ), the center of the explosion. The clearing is described by a vegetation profile of tree remnant height versus the distance from GZ.

Program 3 (FTJPHL) of the model is an automated procedure for evaluating a clearing by estimating how many trees must be removed from a clearing produced by a high-yield, air-dropped munition in order to use the clearing as a full-touch helicopter landing zone. The output is the number of tree remnants that must be removed to satisfy the landing requirements of a specified helicopter.

All three computer programs were designed and written for use on a Honeywell G-635 computer system equipped with extensive time-sharing capability, coded in FORTRAN language, and run in conversational mode by means of a conventional teletype terminal. Maximum core storage for any one program is 10K words.

This report is intended to serve as a guidebook for the individual responsible for running the programs and requires a working knowledge of computer techniques and terminology and various methods pertinent to data processing.

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PREFACE

The study reported herein was conducted in support of DA Project 4A162121AT31, "Research for Lines of Communications Facilities in Theaters of Operations," Task 02, "Airline of Communication Facilities," Work Unit 02, "Site Selection Analysis for Airmobile Operations," sponsored by the Office, Chief of Engineers (OCE), and later DA Project 1T162112A528, "Environmental Effects on Materiel Development," Task 02, "Terrestrial Effects on Materiel Development," Work Unit 03, "Terrain Analysis for Helicopter Operations," sponsored by Headquarters, U. S. Army Materiel Development and Readiness Command. This study was conducted during January 1973-June 1975 by personnel of the Environmental Simulation Branch (ESB), Environmental Systems Division (ESD), Mobility and Environmental Systems Laboratory (MESL), U. S. Army Engineer Waterways Experiment Station (WES).

All phases of the study were under the general supervision of Messrs. W. G. Shockley, Chief, MESL, and W. E. Grabau, formerly Chief, ESD, and now Special Assistant, MESL, and under the direct supervision of Mr. J. K. Stoll, Chief, ESB, and project manager, who planned the project and was responsible for developing the site evaluation logic. Coordinating program activities with writing the computer programs and designing the input and output were the responsibility of Ms. J. A. Parks, formerly of ESB, now of the Aquatic Plant Research Branch. Ms. M. H. Smith, ESB, and Mr. T. D. Hutto, ESB, assisted in writing the computer programs. Mr. M. P. Keown, ESB, provided valuable assistance in formulating some of the logic used in the computer programs. CPT R. D. Brown provided valuable consultation on helicopter characteristics and performance capabilities. This report was written by Ms. Parks.

Directors of WES during the study and preparation of the report were BG E. D. Peixotto, CE, and COL G. H. Hilt, CE. Technical Director was Mr. F. R. Brown.

CONTENTS

Volume I

Page

PREFACE. 2

CONVERSION FACTORS, U. S. CUSTOMARY TO METRIC (SI) AND METRIC (SI) TO U. S. CUSTOMARY UNITS OF MEASUREMENT. 5

PART I: INTRODUCTION. 6

General Background 6
Purpose and Scope 7
Approach 8
Definitions 9

PART II: DESCRIPTIONS OF ANALYTICAL PROCEDURES 11

Procedures Involving Surface Geometry and Soil Strength . . 11
Procedures Involving Explosive Clearing of Vegetation . . . 17
Procedures for Estimating Number of Tree Remnants 31

REFERENCES 40

FIGURES 1-27

TABLES 1-7

APPENDIX A: SUGGESTIONS FOR OBTAINING VALUES FOR TERRAIN DESCRIPTORS A1

Descriptors Required for Program FTHEL A2
Descriptors Required for Program FTJPRH A12
Descriptors Required for Program FTJPHL A18

FIGURES A1-A13

TABLES A1-A3

APPENDIX B: PROCEDURES FOR ADDING HELICOPTER DATA FILES B1

Preparation and Use of General Purpose Data Form B2
Modifications to Program 1 (FTHEL) B3
Modifications to Program 2 (FTJPRH). B4
Modifications to Program 3 (FTJPHL) B5

FIGURES B1-B4

APPENDIX C: EXAMPLE RUNS OF COMPUTER PROGRAMS C1

APPENDIX D: DESCRIPTION OF MATHEMATICS INVOLVED IN PROGRAM FTJPRH D1

FIGURE D1

TABLE D1

APPENDIX E: SPECIAL OUTPUT FILES FROM PROGRAM FTJPRH E1

CONTENTS

Page

FIGURES E1-E4

APPENDIX F: RATIONALE RELATED TO HELICOPTER LANDING ZONE DESIGN F1

Area by Increment F2
Obtaining Probability Value F5

FIGURES F1-F5

TABLE F1

Volume II

LISTINGS OF COMPUTER PROGRAMS

(published under separate cover)

CONVERSION FACTORS, U. S. CUSTOMARY TO METRIC (SI) AND METRIC (SI) TO U. S. CUSTOMARY UNITS OF MEASUREMENT

Units of measurement used in this report can be converted as follows:

Multiply	By	To Obtain
	U. S. Customary to Metric (SI)	
inches	25.4	millimetres
square inches	645.16	square millimetres
pounds (mass)	0.4535924	kilograms
tons (short)	0.90718	metric tons
pounds (mass) per cubic foot	0.01601846	grams per cubic centimetre
pounds (force) per square inch	6.894757	kilopascals
pounds (force) per square inch	6.894757×10^5	dynes per square millimetre
degrees (angular)	0.01745329	radians
	Metric (SI) to U. S. Customary	
millimetres	0.03937007	inches
centimetres	0.3937007	inches
metres	3.280839	feet
square centimetres	0.1550	square inches
square metres	10.76391	square feet
metric tons	1.1023	short tons (2000 lb)
grams per cubic centimetre	62.42797	pounds (mass) per cubic foot
dynes per square centimetre	1.4504×10^{-5}	pounds (force) per square inch
knots (international)	1.151543	miles (U. S. statute) per hour

AUTOMATED PROCEDURE FOR EVALUATING SITES FOR SUITABILITY AS HELICOPTER LANDING ZONES

VOLUME I

DESCRIPTIONS AND INSTRUCTIONS FOR USE OF COMPUTER PROGRAMS

PART I: INTRODUCTION

General Background

1. The use of rotary-wing aircraft (helicopters) in tactical situations is an important characteristic of the U. S. Army's airmobile operations. Experience in all aspects of helicopter use (troop deployment, resupply, evacuation of wounded, etc.) has clearly demonstrated that helicopter operations are severely terrain-dependent. Despite their ability to rise and descend vertically, the machines still require areas of reasonably flat and obstacle-free terrain on which to land under even the best of circumstances. Furthermore, when the machines are heavily loaded, efficient operations require nonvertical approaches and departures, and these attributes magnify the amount of open space required. The existing inability to rapidly and reliably select suitable helicopter landing zones (HLZ's) is a major constraint on the Army's tactical mobility.

2. Many terrains, especially those covered with trees, cannot be used for HLZ's unless the trees are first cleared. Terrain exhibiting a few clearings in the forest is little better, because the development of highly effective shoulder-fired antiaircraft missiles has made the use of existing HLZ's exceedingly dangerous. Creating suitable HLZ's in such situations by the use of conventional methods, such as rappelling engineer troops equipped with hand tools and demolition kits through the forest canopy from hovering helicopters, is inordinately dangerous to both troops and helicopters. In addition, creating an opening of sufficient size to permit the landing of heavy equipment takes so long that all hope of tactical surprise is lost. This situation has been partially

alleviated by the development of large air-delivered munitions that are capable of clearing an opening of sufficient size by blast effects.[1] However, the effective use of such devices is predicated on the assumption that the detonation will clear an adequate area and that the terrain surface beneath the trees will be suitable for an HLZ. Thus, there is a need for a rapid method of assessing terrains in terms of suitability for the use of forest-clearing munitions.

3. In view of these situations, it would clearly be advantageous to have a method of analytically evaluating potential sites for suitability as HLZ's, so that the optimum sites could be selected prior to the initiation of the operation. Since this type of evaluation procedure is necessarily complex, such a capability appears to be practical only by exploiting computers. Once developed, such a computer-effected procedure could then be used repeatedly, regardless of the geographic location of the proposed operation.

Purpose and Scope

4. The purpose of the overall study was to provide U. S. Army combat forces with an analytical procedure that will rapidly and concisely evaluate selected sites in terms of their suitability for use as HLZ's.

5. The procedure comprises three computer programs:

a. Program 1 (FTHEL). This program relates specific helicopter characteristics to selected terrain descriptors (slope, microrelief, and soil strength) to determine the suitability of the site as an HLZ.

b. Program 2 (FTJPRH). This program is a mathematical model of an explosion in a forest. It predicts the size and shape of the clearing that results from the detonation of an explosion of specified yield in a forest described in terms of the stem diameters, heights, and species of the component trees. A submodule makes it possible to compare the size and shape of the opening with the geometric requirements of a specified helicopter, so that the user can determine whether the opening will be adequate.

c. Program 3 (FTJPHL). This program uses a portion of the output of Program 2 as input. One of the products of

Program 2 is an estimate of tree remnant (stump) height as a function of distance from the point of detonation. Program 3 compares these data with selected geometric attributes of a specified helicopter and estimates the number of tree remnants that would have to be removed to provide clearance for the specified helicopter.

6. Volume I of this report includes brief descriptions of the three programs, specifications as to data requirements and the formatting of the necessary files, and instruction for the use of the programs. Volume II consists chiefly of the statement listings of the three programs.

Approach

7. This report has been written on the assumption that the reader will have some experience in using a teletype terminal and a time-sharing computer system. As with all computer operations, the user must follow established procedures and formats to the letter; it is sometimes difficult for a novice to appreciate the necessity for this. Nevertheless, the user by no means needs to be an expert. The programs are written in "conversational" mode so that the user is led through the correct procedure step by step. The user need only follow the instructions implicitly.

8. Each of three computer programs comprising the analytical procedure is a separate and self-contained module. Individually each consists of an essential component of the evaluation. Collectively they provide all of the data required to determine the suitability of a site as an HLZ. The modular design was used so that the user could omit one or more of the evaluation steps, since not every site will require them all. For example, if the user knew ahead of time that the ground surface beneath a forest is smooth, flat, and hard, the use of Program 1 would not be needed, since the user would already know that a full-touch zone (FTZ; see paragraph 10d) would be available if the trees could be cleared away. The user would then start the analysis with Program 2.

Conversely, if the region was devoid of trees, but the ground was rough, the user would need only Program 1.

9. All three computer programs were written to be run on a Honeywell G-635 system that has time-sharing capability. Conversion of the codes for use in batch or remote batch modes would require several modifications, primarily in the input and output statements. Although such modification is not recommended, it might become unavoidable if the user found it necessary to evaluate a large number of sites. In this event, it is recommended that only an experienced programmer undertake the effort.

Definitions

10. The following expressions are used in this report in somewhat specialized senses. In some instances, abbreviations and acronyms are used in the text to avoid repetitious use of lengthy terms; the abbreviations and acronyms are given in parentheses immediately following the terms.

a. Data array. In the terminology of this report, a data array is a body of information stored in core memory, excluding program statements.

b. Data file. In computer terminology, a data file is a body of information stored other than in core memory. It may be on disc, magnetic tape, paper tape, or whatever.

c. Departure angle. The acute angle between the horizontal and a line generated by the helicopter as it rises from its touch zone. The line intersects the ground at the perimeter of the touch zone. The departure angle is controlled primarily by the type of helicopter and the load being carried at takeoff.

d. Full-touch zone (FTZ). A patch of ground so configured that a fully loaded helicopter can come completely to rest on the ground. An FTZ must be quite flat, free of obstacles larger than a critical size related to the specific helicopter, and with soil strength adequate to support the weight of the aircraft.

e. Glide angle. Synonym for departure angle.

f. Ground zero (GZ). The location of the point on the ground immediately below the point of detonation of an

explosive. It is commonly used as the origin of a radial coordinate system used to describe the propagation of the explosion-driven shock wave and related pressure wave.

g. Helicopter landing zone (HLZ). A patch of ground so configured that it meets the criteria of an FTZ, a skid-touch zone (STZ), or a nontouch zone (NTZ).

h. No landing zone (NLZ). A patch of ground so configured that a helicopter cannot approach close enough to make loading or unloading practical.

i. Nontouch zone (NTZ). A patch of ground so configured that a helicopter can approach close to the ground, but not touch. Thus, loading and unloading must be achieved with the aircraft in full hover. NTZ's are usually characterized by steep slopes, complex microrelief (such as boulders or tree stumps), or tall vegetation.

j. Program statement. In this report, a program statement is a numbered line of instructions which forms an integral and essential part of the computer program.

k. Skid-touch zone (STZ). A patch of ground so configured that only one skid, or the tips of both skids, can be brought into contact with the ground. In this situation, the weight of the helicopter is largely, but not completely, supported by the rotor. In a skid-touch mode the helicopter is relatively unstable, and loading and unloading require great pilot skill. STZ's are commonly characterized by a significant terrain slope.

l. Touch zone radius (TZR). The radius of the essentially obstacle-free area required for an FTZ. The radius is a function of helicopter size and configuration.

PART II: DESCRIPTIONS OF ANALYTICAL PROCEDURES

Procedures Involving Surface Geometry and Soil Strength

Description of computer program FTHEL

11. The analytical procedure for classifying terrain in terms of its suitability as an HLZ is consolidated into a computer program designated FTHEL. It consists of a main program and one subroutine. FTHEL is composed of sets of comparisons and decisions. The comparisons match terrain conditions against geometrical and operational characteristics of helicopters; the decisions are simply determinations as to whether the terrain will meet the geometrical and operational requirements of the helicopters. Those conditions that will not permit safe operation are identified; those that will permit operation are classified according to the type of landing that is permitted. A flow chart of the analytical procedure is given in Figure 1, and the program is listed in its entirety in Volume II of this report.

12. The first terrain characteristic examined in the computer program is slope (ASL in Figure 1). The program asks if the slope of the terrain is greater than those values that are the maximum allowed for a given helicopter to safely come to a full rest on the ground, come to a rest with only one skid on the ground, or hover close to the ground, or whether the machine cannot achieve any of these. If any of the first three types of landings can be achieved, the program internally characterizes the site as either an FTZ, STZ, or NTZ. If the terrain slope is too steep to permit any of the three, the program classifies the site as an NLZ, outputs that information, and terminates.

13. If the site has been classified tentatively with respect to slope as a FTZ, STZ, or NTZ, the program then compares the microrelief characteristics of the site with certain physical characteristics of the helicopter, such as ground clearance of the hull, height of the rotor blades in both lift and idling modes, touch zone radius, rotor blade length, etc. On the basis of these comparisons, the program decides

whether any microrelief features will interfere with the helicopter in any essential way.

14. The first set of comparisons determines whether any of the microrelief features are high enough to impale the hull of the machine if it lands, or high enough to interfere with the rotor disc or snag the tail rotor, and so on. If the microrelief features are too small to cause any interference, the program simply proceeds to an evaluation of soil strength. However, if some features are large enough to be potentially dangerous, the program determines which height class of microrelief features can impale the hull and examines the area between the microrelief features to determine if the machine can land successfully between them. This is accomplished through the medium of the sample cell. The sample cell (see Appendix A, paragraph 22) is a circular area occupied by 20 features (Figure A8). Thus, if the area of the sample cell is divided by 20, the resultant is the average area assigned to a single feature, and the diameter of that area is the mean spacing of the feature.[2] Thus,

$$S = \frac{D}{\sqrt{N}} \tag{1}$$

where

S = mean spacing (which approximates the average distance between the centers of all microrelief features large enough to interfere with the helicopter)

D = diameter of the sample cell

N = number of features in the sample cell

Equation 1 appears in the subroutine SPACE (lower right corner of Figure 1). The average diameter of the features (see Appendix A) is subtracted from the mean spacing to obtain a value which is, in effect, the mean free open space between microrelief features. This value is then compared with appropriate helicopter characteristics, such as hull width, to determine if there is enough unimpeded space to accommodate the helicopter.

15. Based on the height of microrelief features and the mean free space between them and the geometry of the specified helicopter, the

program then classifies the site as either an FTZ, STZ, NTZ, or NLZ.

16. The next step is to recall the classification based on slope alone and compare it with the one based on microrelief alone. If both are the same, no further decision is necessary, and the program stores the classification for future reference. However, if the two are different, the worst condition is chosen and stored. For example, if the classification based on slope is FTZ and that based on microrelief is NTZ, the program selects NTZ and retains it for future reference. If the classification with respect to microrelief is NLZ or NTZ, the program prints out that result and terminates.

17. If the classification at this point is STZ, the program transfers to a routine that computes the departure angle (see paragraph 19). If the classification is FTZ, the program proceeds to an analysis with respect to cone index (i.e. soil strength; see Appendix A).

18. If the site is tentatively classified as an FTZ, the implication is that the full, loaded weight of the helicopter will come to rest on the ground. Therefore, the program compares the cone index of the soil at the site with the minimum cone index required by the helicopter (see item labeled "CONE INDEX FOR AN FTZ, MAXIMUM LOAD (PSI)" in the helicopter data files, Tables 1-5). If the minimum cone index required by the helicopter is greater than the cone index of the terrain, the soil is too weak to permit the helicopter to come to a full rest, so that site is classified as an STZ. However, if the helicopter value is equal to or less than the terrain value, there is sufficient strength to support the machine, and the classification is thus FTZ.

19. Following classification of the site on the basis of cone index, the program proceeds to a calculation of departure angle. Allowances are made for minimum touch zone radius and the height and spacing of microrelief features (Figure 2). The helicopter is situated at the center of the touch zone; this defines the distance of the helicopter from the edge of the zone. The program calculates the departure angles for all microrelief features in the site and selects the steepest angle as the departure angle that characterizes the site. The line

formed by the departure angle is normally called the "glide path," as labeled in Figure 2.

20. At this point, the program prints out the final site classification and the calculated departure angle and terminates.

Input requirements for FTHEL

21. Helicopter data files. Program FTHEL uses a set of data files containing information describing five widely used Army helicopters: UH-1H Iroquois,[3,4] UH-1B Iroquois,[4] OH-6A Cayuse,[5] CH-47A Chinook,[6,7] and CH-47C Chinook.[6,7] Thus, if the user is concerned with one of these aircraft, he need only identify the proper machine from the list at the time the program asks for it, and the program will automatically retrieve all relevant data from the appropriate file. The data stored for each helicopter are given in Tables 1-5.

22. Several of the descriptors included in the helicopter data files are not needed for this program. They were included only to provide a rounded description of the machines and in anticipation of possible future additions to the overall analytical routine.

23. Since it is unlikely that all users will be interested only in the five helicopters already included in the data files, provision has been made for adding additional helicopter data files as needed. The procedure for adding additional helicopter data files to the program is given in Appendix B.

24. Terrain data. Three terrain characteristics are required to satisfy the requirements of FTHEL: slope, microrelief, and cone index. Values relevant to these terrain attributes are called for by the program at a certain point. To ensure that all needed data are available at that point, it is strongly recommended that the "Data Input Form for FTHEL" (Figure 3) be used and completely filled in prior to initiating a run of the program. It will be noted that the data form is divided into two parts: Microrelief Feature Data and Additional Terrain Descriptors. The following paragraphs discuss the terrain data requirements in the order of their appearance on the data form (Figure 3):

a. Microrelief. In the content of program FTHEL, microrelief features are localized irregularities in the general

terrain surface which are of such magnitude that they affect the landing of helicopters. Typical features are boulders, stumps, termite mounds, potholes, etc. Linear features having a length/width ratio greater than 3.0 are excluded from consideration. Microrelief features are described by combinations of three factors: height, average diameter, and number of features per unit area. It will be noted that the data form (Figure 3) has six columns, each of which is devoted to a specific height class of microrelief feature (see Appendix A). If there are no features in certain of the height classes, zeros must be placed in the spaces allotted those classes. Detailed instructions for obtaining microrelief data and filling out the "Data Input Form for FTHEL" are provided in Appendix A.

b. Cone Index. This descriptor is technically the force (in $lb/in.^2$*) required to push a right circular cone with an apex angle of 30 deg and a basal cross-section area of 0.5 $in.^2$ through a soil to a depth pertinent to the type of data being collected. For helicopter landing the average of cone index values obtained at the surface and at 3-in. increments to a depth of 12 in. is used. In practice the reading is usually treated as a dimensionless number. This reading is the value that is required by program FTHEL.

c. Slope. This is the angular deviation of the surface (of the ground) from the horizontal, measured perpendicular to the topographic contours.[8] Program FTHEL requires that the value be stated in degrees.

Suggestions for methods of obtaining values for the various terrain descriptors are given in Appendix A.

25. With the "Input Data Form for FTHEL" completely filled in (i.e. with values in every position), the user inputs the appropriate values on the teletype as they are called for by the program. Detailed instructions for this procedure are given in paragraphs 26-34.

Instructions for use

26. Use of program FTHEL is predicated on the assumption that the user will: (a) know which helicopter is to be used in the evaluation and (b) have a completely filled in data form (Figure 3). As an example

---

* A table of factors for converting U. S. customary units of measurement to metric (SI) units and metric (SI) units to U. S. customary units is presented on page 5.

of the specific procedure, let us assume that the helicopter at issue is a CH-47A Chinook and that the terrain data are as given in Figure 4, which is a completely filled-in example of the data form given in Figure 3.

27. After the user has called Program 1 into working storage and typed RUN, the teletype will print the list of available helicopters, as illustrated at the top of Figure 5, and the request that the user select one of the helicopters. Since the user is interested in the CH-47A, he types 4 (A in Figure 5), which is the numerical code designating the file in which data for that helicopter are stored.

28. The program (Figure 5) then asks for an indication of which of the two TZR's is desired. The smaller of the two (which is labeled in Tables 1-5 "RADIUS OF TOUCH ZONE - MINIMUM") is an area that barely permits rotor blade clearance and is thus a situation to be avoided except in emergencies. The larger of the two (which is labeled in Tables 1-5 "RADIUS OF TOUCH ZONE - MAXIMUM") is an area that provides a substantial amount of clearance on all sides and is the one usually chosen for normal operations. In the example, the user chose the maximum TZR, i.e. 26 (B of Figure 5).

29. The program then requests that the maximum height of the microrelief features in each height class be input, starting with the largest. Referring to Figure 4, the array of numbers required is found in the first line of pigeonholes under Section A, i.e. 4.5, 3.2, 2.5, 2.0, 0.5, and 0.1. The user has input them correctly (C in Figure 5); note that the correct input order is from the largest (Height Class VI) to the smallest (Height Class I). If there are no features in a particular height class, the blanks for that height class on the form are filled with zeros. For example, if Height Class III in Figure 4 contained no features, the numbers input would be 4.5, 3.2, 2.5, 0.0, 0.5, and 0.1.

30. The program now requests the average diameter of the microgeometry features in each height class, in the same order as the height class values. These numbers are found in the second line of pigeonholes under Section A of the data form (Figure 4). Again the user has

input them correctly (D in Figure 5), i.e. 50, 65, 30, 28, 10, and 5. Any height class having no features in it will have a zero in its position in the number string of diameters. For example, if Height Class III was empty, the input would be 50, 65, 30, 0, 10, and 5.

31. The next program request is for the number of microrelief features in each height class, again in the same order. These numbers are found in the third line of pigeonholes in Section A of the data form (Figure 4). In this one the correct numbers are 20, 18, 18, 20, 23, and 30 (E in Figure 5). Again, if Height Class III was void of features, the numbers to be input would be 20, 18, 18, 0, 23, and 30.

32. At this point the program requests input of the numbers recorded in Section B of the data form (Figure 4): cone index (100), largest sample cell radius (50), and ground slope (2). Again the user has input them correctly (F in Figure 5).

33. If all of the data are acceptable, the program signals that fact by a row of plus (+) signs and then prints a classification of landing zones and a brief instruction as to the implications of each (G in Figure 5). The program then asks if the user would like to see the definitions of the landing zone classification. In the example, the user indicated that he would like to see the definitions by typing YES (H in Figure 5). At this response the computer prints a set of definitions of the landing zone classes.

34. Immediately following, the program prints the classification of the landing zone (I in Figure 5) and a calculation of the departure angle <u>if</u> the classification is either FTZ or STZ. If it is NTZ (example in Figure 5) or NLZ, the program indicates that no departure angle is calculated.

35. Appendix C provides additional examples of computer runs, involving other combinations of terrain factor values and helicopter types.

<u>Procedures Involving Explosive Clearing of Vegetation</u>

<u>Description of computer program FTJPRH</u>

36. Program FTJPRH predicts the size and shape of a clearing in a

forested area by considering the blast forces from an explosion, tree stem strength, stem diameter, and distance from GZ. It also has an option for comparing the vegetation profile of this clearing to the profile established by the requirements for the landing of a specified helicopter.

37. The program is written in FORTRAN language for use on a Honeywell G-635 system that has time-sharing capability. It is designed to be run in conversational mode, in which the computer asks questions and makes requests and the user responds accordingly through means of a conventional teletype terminal. The program requires approximately 10K words of core storage. Output consists of tables printed on the teletype and a single disc file of variable length. A computer listing of the program (main program and nine subprograms) is given in Volume II of this report.

38. Program FTJPRH is a long, involved program by time-sharing standards, and modification is strongly discouraged except when absolutely unavoidable. Even an experienced programmer may encounter difficulty in tracing variables, separating procedures, and locating all situations that are affected by what seems to be only a minor change.

39. Program FTJPRH first evaluates the interaction between the shock wave of an explosion (which has been characterized in terms of yield in metric tons of TNT) and an array of trees described in a specific way. The precise evaluation method (see Appendix D for a discussion of the mathematics involved) is dependent upon the elegance of the description of the tree array; the program operates in one of three computational modes depending upon the type of tree array description that is provided. The three types of tree array descriptions are designated as "Input Formats" or, more simply, "Formats."

a. Format 1. This description requires very detailed information on individual trees, including for each species its common name, modulus of rupture, Young's modulus, wood density, and stem diameter (Figure 6). Details for preparing the input data forms are given in Appendix A. If the program is presented with Format 1, it evaluates the tree and predicts the height at which the stem will break at various distances from GZ. That

is, it predicts the height of the stump that will remain after the passage of the shock wave. The remnant height data are presented as they appear in the output file in Figure 7.

b. Format 2. As shown in Figure 8, this generalized description of the tree array is confined to three values: (1) the maximum wood strength found anywhere in the site; (2) the maximum stem diameter exhibited by a tree having the maximum strength; and (3) the height of the tallest tree having the maximum strength. Details for obtaining these data and preparing the input form are given in Appendix A. If the program is presented with this format, it evaluates a tree of the type described located at short increments of distance from GZ and predicts the remnant height of such a tree at each distance increment. The remnant height data are presented in Figure 7 as they appear in the output file.

c. Format 3. This format (Figure 9) requires that the trees on the site be first classified into six strength classes and then into nine diameter classes. Details for obtaining the data and preparing the input data form are given in Appendix A. When presented with this format, the program identifies each combination of descriptors found in the data input (i.e. each combination of stem diameter, wood strength, and tree height) and evaluates each such combination at each distance increment. Each combination of descriptors results in a unique set of remnant height data. As each combination is input, the appropriate computations occur and the remnant height data are written into the output file, as presented in Figure 7. When all combinations have been run, the output file is made up of as many sets of remnant height data as combinations input. That is, if there are five combinations of stem diameter, wood strength, and tree height in the input data (Figure 9), there will be five output sets like Figure 7.

40. Regardless of the input format, the program calculates a "profile" starting at 3 m from GZ (see paragraph 78) that represents the height of the tree stumps as a function of distance from GZ. A plot of one of these relations (Figure 10) shows that the surface generated by the remnant heights resembles a crater. To land, a helicopter must descend into this crater without touching the walls or being impaled by tree remnants in the actual touch zone at the center of the crater.

41. At this point, the user can invoke a program subroutine that compares the geometry of the vegetation "crater" with the size and

flight constraints of a user-selected helicopter. Given a user-selected helicopter and its TZR and departure angle (Figure 2), the program then compares the geometry of the volume of space formed by the TZR and departure angle with the geometry of the vegetation crater.

42. The output of the comparison portion of program FTJPRH is a tabulation that lists both the tree remnant height and the height of the glide path (helicopter hull clearance in the touch zone) as a function of distance from GZ (Figure 11). Alternative methods of displaying the same data are given in Figures 12 and 13.

Input requirements for FTJPRH

43. Weapon yield. Weapon yield (hereafter called yield) is defined as the total effective energy released in an explosion and is usually expressed in terms of the equivalent tonnage of trinitrotoluene (TNT) required to produce an explosion of the same magnitude.[9] In this computer program, the yield is expressed as metric tons of TNT.

44. In most cases, a general-purpose bomb will probably be selected from an available inventory, and its yield will be input. Bombs are usually described in terms of their total weight (in pounds) including the housing and fill. This value is reduced to weight of the fill, or explosive, expressed as an equivalent weight of TNT, and used to calculate the yield of the explosive. Table 6 is a brief list of some general-purpose bombs and the conversion factors that were used to calculate their yields.

45. If the bomb to be used is not included in the list in Table 6, its yield can be converted as required for this program to metric tons of TNT. In this conversion process the key factors are the weight of the fill in the bomb (pounds) and the factor converting that weight to pounds of TNT, as illustrated below.

a. A 10,000-lb general-purpose bomb has tritonal fill that weighs 7,477 lb.

b. The conversion factor relating tritonal and TNT is 1.07.[1]

c. The conversion factor to metric is: 1 metric ton = 1.1023 tons (U. S. customary units).

$$\text{Yield in metric tons TNT} = \frac{\text{weight, lb TNT}/2000}{1.1023}$$

$$= \frac{7477 \times 1.07/2000}{1.1023} = 3.63$$

46. Vegetation data. Since the reliability of the remnant height predictions depends largely on the accuracy and level of detail of the vegetation descriptions, those descriptions must be made with great care. Any one of three formats can be used (see paragraph 39). The choice of which to use is normally a trade-off between the amount and reliability of available data and the nature of the desired evaluation. Thus, for a "quick look" at a number of possible sites, the user might choose to use Format 2, which is a highly generalized description. Then, when the choice of general region has been decided upon, the user might shift to either Format 1 or Format 3 to provide data for his final choice.

47. The three input formats for vegetation data are described briefly below. Detailed instructions for obtaining the requisite data and filling in the appropriate data forms (Figures 6, 8, and 9) are given in Appendix A.

a. Format 1. This format can be used only in situations in which detailed information is available for every tree in the site. Only rarely will such information be available.

b. Format 2. This format can be used in situations in which only very general tree information is available. It has one important advantage: Both data input time and computation time are much less than that required for either Format 1 or Format 3.

c. Format 3. This format is intermediate between Formats 1 and 2. In this format, the trees are described in terms of parameter classes, rather than in absolute values as in Format 1 or in gross generalizations as in Format 2. The procedure requires that all trees exhibiting the same combination of classes (i.e. ranges of values) of stem diameter, wood strength, and tree height be evaluated at the same time. In effect, the program treats a class as if it were a single tree.

48. Helicopter data. Program FTJPRH requires a set of data files

containing information describing a helicopter. As stated in paragraph 21, five widely used Army helicopters are in the data files: UH-1H Iroquois, UH-1B Iroquois, OH-6A Cayuse, CH-47A Chinook, and CH-47C Chinook. Thus, as in program FTHEL, if the user is concerned with one of these aircraft, he need only identify the machine from the list at the time the program asks for it (see paragraphs 54-77), and the program will automatically retrieve all relevant data from the appropriate file. The data stored for each helicopter are given in Tables 1-5.

49. After the helicopter has been selected, the user must make two important decisions. The helicopter data files include two values for TZR. For example, in Table 1, the two are 10.5 and 15.0. The user must select one of these. The second decision is the selection of a departure angle. In the helicopter data file there is a value for minimum departure angle and one for maximum departure angle (Table 1), and these are set by the lift-off and landing requirements of the individual helicopter. Within the range set by this maximum and minimum, the user is allowed to select a value for the departure angle. If an angle was calculated and output by FTHEL, and that angle lies within the given range, the user should use it as the departure angle requested in FTJPRH.

50. It is entirely possible that a user will need to perform the evaluation using helicopters other than those in the existing data files. Provision has therefore been made for adding additional helicopter files as needed. The procedure for doing so is given in Appendix B.

51. Not all of the descriptive data included in the helicopter data files are used in program FTJPRH. The descriptors actually used are listed in Table 7.

52. Output file name. It will be noted that all three vegetation data forms (Figures 6, 8, and 9) require an "Output file name." This is necessary because the remnant height versus distance to GZ data generated by program FTJPRH are treated in two different ways. In the first mode, the data are generated and immediately placed in a separate file. Since the computer system must have an allocated space in peripheral storage

for this file, it is necessary to provide a name for the allocated space. The name must have the following characteristics (see Appendix E):

- a. It must begin with an alphabetic character.
- b. It cannot contain more than six characters (it can be any combination of letters and numbers).
- c. It must be unique in the file catalog where the program resides.

In the examples included in this report, the file name is RHF plus a number. Each time a data set is generated, a new name must be assigned for its file. In most cases, it is convenient to number the files sequentially. Thus, if three evaluations are made, the file names might be RHF1, RHF2, and RHF3.

53. In the second mode, the remnant height versus distance to GZ data go directly to an output device and are printed in the form of a table (Figure 11) at the time they are produced.

Instructions for use

54. Program FTJPRH is a conversational mode program arranged in such a way that the user has a wide range of options depending upon the type of vegetation data available to him and upon the type of analysis with which he is concerned. Figure 14 is a flow diagram illustrating the options in the program. In the following discussion, the notation "Block 1," "Block 2," etc., refers to numbered outlined blocks in the flow diagram. The following legend applies to the flow diagram:

- a. Outlined numbered blocks are somewhat abridged notations of the questions or specific instructions which the program presents to the user.
- b. Statements in brackets are sets of procedures, instructions, or computations that occur in the program based upon the input provided by the user.
- c. Statements in braces concern the input data requirements.
- d. Letters in hatched boxes indicate entry points into the program from other positions in the program.
- e. Circles and rounded-end boxes are directional markers throughout the procedure.

55. The use of program FTJPRH is predicated on the assumption that the user has the following:

a. The yield of the weapon for which he wants the evaluation.

b. One or more of the sets of vegetation descriptions. That is, he has one or more of the vegetation input data forms (Figure 6, 8, or 9) filled in and ready.

c. The identification of the helicopter in which he is interested, including the TZR and departure angle for which he wants the evaluation.

56. The procedure is to call program FTJPRH into working storage and type RUN on the teletype to initiate the program.

57. The following discussion may be followed in part in Figures 15, 16, and 17, which are copies of teletype printouts obtained as a user went through a number of the program operations for three sets of input data. Lettered arrows in Figures 15, 16, and 17 are used to indicate where in the printout the blocks (Figure 14) are located. The program (Block 1) first asks whether the user is familiar with the program (A, Figures 15, 16, and 17). If the user responds by typing NO, the program prints out a general description of the program and its input requirements (A, Figure 15, sheets 1-2). After the general statements are complete, the program informs the user that he will now have to answer a specific series of questions. If the user responds to the questions concerning knowledge of the program (Block 1) by typing YES (A, Figures 16 and 17), the program goes directly to a set of questions relating to data input.

58. At this point, the program first asks for the yield of the weapon for which the evaluation is to be made (Block 2; B, Figures 15, 16, and 17). As soon as this has been provided, the program asks for an identification of the data input format to be used (Block 3; C, Figures 15, 16, and 17). The user must specify whether he intends to use Format 1, 2, or 3 (see Appendix A).

59. Regardless of which format the user selects, the program asks for the name of the output file which is to contain the data on remnant heights and their distances from GZ (Block 4; D, Figures 15, 16, and 17). Note that each of the three vegetation data forms (Figures 6, 8, and 9) includes a blank on which this name is noted. This requirement is discussed in general in paragraph 52 and in detail in Appendix E.

60. As soon as an acceptable name is entered, the program prints a line of stars across the page, indicating that it is now ready for specific inputs.

61. Format 1 (Figure 15). If the response to the question concerning input format (Block 3) is "1," indicating an intent to use Format 1, the computer then asks for data as listed in Figure 6. An example of a filled-in data form is given in Figure 18. In detail, the program asks for the following four sets of information describing the characteristics of the tree species:

a. The first request is for the common name of the tree species. In the example (Figure 18) the tree species is Englemann spruce (E, Figure 15).

b. The next request is for a set of three items: the tree identification number, the modulus of rupture, and Young's modulus (F, Figure 15). Since this is the first tree in the analysis, the tree identification number is 1. On the data form (Figure 18) the modulus of rupture and Young's modulus are both written in computer exponential notation. This notation is used because conventional exponential notation cannot be used on a computer. The format conversion is:

Conventional Exponential	Computer Notation
3.103×10^8	3.103E+8

c. The third request is for the wood density (G, Figure 15), with a special provision for entering specific gravity and moisture content (H, Figure 15), which is an acceptable alternative to wood density. In this case, the wood density is listed as 0.58. However, when entered on the teletype (bottom of sheet 3, Figure 15), note that this value must have a 1 on each end, separated from the density value by commas, as indicated at the top of sheet 4, Figure 15. When the wood density is not available and the specific gravity and moisture content are to be input instead, the teletype entry is very similar. The values of specific gravity and moisture content are input, preceded by the number 2. At H in Figure 15 is an example of this kind of input.

d. Finally, the fourth request is for stem diameter and height data (I, Figure 15). Note that stem diameter must be given in centimetres, while the tree height must be stated in metres.

62. Upon completion of data input items 1-7 (Figure 18), the distribution of the trees throughout the test site is considered by one of three options:

- a. Option 1. The exact location of the tree is not known. In this case, the program computes the remnant height for each tree at 1-m increments from 3 to 40 m from GZ (Block 5; J, Figure 15). These computations produce vegetation profiles needed to evaluate the site for HLZ's as discussed below.
- b. Option 2. The radial distance to the tree is known. In this case, the program computes the remnant height for each distance specified.
- c. Option 3. The XY-coordinates of the tree are known. In this case the program computes the remnant height for each XY-coordinate specified.

63. If the user wants tree remnant heights calculated at 1-m intervals (option 1), he types YES (J, Figure 15), and the program asks whether the user wants to compare the tree remnant height profile and the landing zone geometry required for a helicopter (Block 7; K, Figure 15).

64. If the user responds to the question in Block 7, by typing YES (K, Figure 15), the program then asks for the following information in sequence:

- a. Selection of a helicopter from the list presented (Block 8; L, Figure 15).
- b. Selection of a TZR from the two presented (Block 9; M, Figure 15).
- c. Selection of a departure angle. The program gives an upper and lower limit; any angle between the two may be selected (Block 10; N, Figure 15).

65. If all entries are acceptable, the program prints a line of stars to indicate that it is proceeding with the evaluation, and then prints out two sets of data. The first consists of a listing of all of the input data, thus providing the user with a ready check to ensure that the input values were correct (bottom of sheet 4, Figure 15). The second set is a table comparing tree remnant height and the height of the glide path as a function of distance from GZ (sheet 5, Figure 15).

66. If the user responds to the question in Block 5 (J, Figure 15)

by typing NO the program assumes that the user has data defining the actual positions of trees with respect to GZ. The program then asks whether the user has data involving radial distances, or whether the tree locations are specified by XY-coordinates (Block 6). If the user indicates that he has data in the form of radial distances, the program then asks for the number of such distances. When that answer has been provided, the program asks that the user enter all such distances in ascending order. When these entries have been made, the program shifts back to Block 7 (paragraph 63) and proceeds as before (paragraphs 63-65).

67. If the user responds to the question in Block 6 by indicating that he has data in the form of XY-coordinates, the program asks for the number of such coordinates, the coordinates of GZ, and finally the coordinates of all the trees. Upon completion of all entries, the program shifts back to Block 7 and proceeds as before.

68. There is an option unique to those situations in which vegetation input Format 1 is used. Because analysis with this format deals with a single species at a time and there may be several species located within one site, the program allows the user to input data for several species. The indication for doing this is answering YES to the question in Block 17 (Do you have another tree species? - O, Figure 15). If the answer to the question in Block 17 is NO, the program proceeds to Block 18 (P, Figure 15) and presents the user with four procedural options:

- a. The first option asks if the user wants to evaluate another site using the same weapon yield. If the user selects this option, the program goes to Box B and proceeds from there as before.
- b. The second option asks if the user wants to evaluate another site using a different weapon yield. If the user selects this option, the program goes to Box A and proceeds from there as before.
- c. If the third option is selected (evaluate the same site using a different weapon yield), the program asks for a new weapon yield (Block 19) and new output file name (Block 20). The procedure then goes to Block 5.
- d. If the fourth option is chosen (end the program), the program stops.

69. Format 2 (Figure 16). If the user, in reply to the question concerning the type of vegetation data he intends to use (Block 3), indicates that he intends to use data in Format 2 (Figure 16, arrow C), the program first asks for the name of the output file (see paragraph 59; D, Figure 16) and then provides instructions for the input of Format 2 data (E, Figure 16). A completed example of a Format 2 data form is given in Figure 19. When all of the data have been input, the program shifts to Block 7 (F, Figure 16) and proceeds as before. The output is a table, as illustrated on sheet 3, Figure 16.

70. After the first set of data has been entered, the program presents five questions concerning the nature of the product desired by the user (Block 11; G, Figure 16):

a. If the user selects option 1 (remnant profile and another departure angle), the program then asks for a new departure angle (Block 12). After this has been provided, the user receives a table comparing the remnant profile generated by trees having the strength class and the maximum height and diameter indicated by the input data and the height of the glide path as a function of distance from GZ.

b. If the user selects option 2 (remnant profile and another TZR, Block 13), the program asks for a new TZR and outputs a table as in item a above.

c. If the user selects option 3 (remnant profile and another departure angle and TZR, Block 14), the program asks in sequence for another TZR (Block 9) and departure angle (Block 10), and the user then receives a table as described in item a above.

d. If the user selects option 4 (remnant profile and another helicopter), the program asks for the identification of the new helicopter (Block 15), a new TZR suited to the new helicopter (Block 9), and a new departure angle (Block 10), after which the user receives a table as described in item a above.

e. If the user selects option 5 (no more), the program proceeds according to which input format was used (Block 16).

71. When Format 2 is used, the program now proceeds to Block 18 and presents the user with four procedural options (H, Figure 16):

a. The first option asks if the user wants to evaluate another site using the same weapon yield. If the user

selects this option, the program goes to Box B and proceeds from there as before.

b. The second option asks if the user wants to evaluate another site using a different weapon yield. If the user selects this option, the program goes to Box A and proceeds from there as before.

c. If the third option is selected (evaluate the same site using a different weapon yield), the program asks for a new weapon yield (Block 19) and new output file name (Block 20). The procedure then goes to Box C.

d. If the fourth option is chosen (end the program), the program stops.

72. Format 3 (Figure 17). If the user indicates in answer to the question in Block 3 (Which input format do you want to use?) that he wants to use Format 3, the program first asks for the name of the output file (Block 4; see paragraph 59). When that has been provided, the user receives instructions for inputting Format 3 vegetation data (C, Figure 17). An example of a completed Format 3 data form is given in Figure 20.

73. The program then asks if there are any trees in strength class 1 (E, Figure 17). If the answer is YES (bottom of sheet 1, Figure 17), the program then lists the diameter classes from 1 to 9 in sequence (sheet 2, Figure 17), and the user must provide for each class the stem diameter and tree height. As soon as this process is complete, the program asks if the user wants to compare the tree remnant height profile for the largest diameter class in which stem diameter and tree height are not zero and the landing zone geometry required for a helicopter (Block 7; F, Figure 17).

74. If the answer to the question in Block 7 is YES, the program asks the user to select in sequence:

a. A helicopter (Block 8).

b. A TZR (Block 9).

c. A departure angle (Block 10).

The user then receives a table (sheet 5, Figure 17) as output. At the top is an identification of the helicopter, departure angle, radius of touch zone, weapon yield, and the vegetation data. The balance of

the table is a comparison between tree remnant height and height of glide path. After the table is printed, the program goes to Block 11 (H, Figure 17) and asks the user which path to follow (see paragraph 70). When option 5 is selected, the program asks if all six strength classes have been run (Block 16). If the answer is NO, the program goes to Box D; if YES, it goes to Block 21.

75. If the answer to the question in Block 7 is NO, the program immediately asks if there are any trees in strength class 2 (G, Figure 17). If the user responds with YES, the program asks for new data in the same manner as described in paragraph 73, and the procedure goes forward as before, except that the question as to comparison is now based on strength class 2.

76. If the user indicates that there are no trees in strength class 2 by typing NO, the program immediately asks if there are any trees in strength class 3. Depending on the user's reply (YES or NO), the procedures described above are repeated, strength class by strength class, until all are completed.

77. When all input for the six strength classes is completed, and "no more" comparisons are to be made, the program goes to Block 21 (I, Figure 17), where the user is given three options: (a) option 1 directs the program to Box B and the procedure continues; (b) option 2 directs to Box A and continues from that point; and (c) option 3 stops the program.

Special limitations of FTJPRH

78. There are two important items concerning the output of this program that warrant special notation and attention. In the interval between GZ and a circular sweep of 3-m radius from GZ, there are no remnant height predictions made. This limitation is imposed by the mathematical solution of the nomograph upon which this program is based; therefore, an alternative procedure is provided. To prevent complications in other computer programs that use these output files as their input data, the distances from GZ that fall within this range have remnant heights that are arbitrarily assigned a value of 0.0001. This height is too small to bear any real significance; however, it is

greater than zero, and this prevents many difficulties that arise if division by this value is required in some mathematical operation. This value of 0.0001 is placed in the output file, but in the printed table the heights falling within this range are deleted and not printed. This makes the initial point in the profile located at 3 m from GZ.

79. A second limitation is the gap that frequently can be detected between the next-to-last predicted remnant height and the last one in the vegetation profile. There are two sets of conditions that can cause this gap, both controlled by the function of the mathematics in this code. The remnant height can be predicted with confidence only to a certain maximum value for each reference case, and when that value is attained, the next value, which would be invalid, is replaced by the height of the tree; and from that point on the tree height is used instead of a predicted remnant height. A second circumstance is that the distance from GZ is of such magnitude that the tree at that distance is undamaged by the blast. Here again the tree height becomes the remnant height from that distance on. In the table of comparisons, the tree height is marked by an asterisk to pinpoint the distance from GZ past which there can be no predictable damage to a tree (Figure 11).

Procedures for Estimating Number of Tree Remnants

Description of computer program FTJPHL

80. Computer program FTJPHL is a procedure for estimating the number of trees that will have to be removed by manual processes from a clearing produced by an air-dropped munition in order to make it acceptable as an HLZ for a user-selected helicopter. It accomplishes this by comparing the profile of remnant heights remaining in the blast-cleared vegetation crater (Figures 10 and 12) with the geometric configuration of the landing zone required by the helicopter selected by the user. For example, and referring to the situation portrayed in Figure 12, a UH-1B helicopter attempting to land might impale itself on any of the stumps that extend above the "profile of landing zone geometry" in the actual touch zone (the circular area extending outward a radius of 15 m

from GZ), or it might collide with any stems at the outer edge of the vegetation crater on the way in or out. Note that in Figure 12 the remnants beyond about 30 m from GZ extend above the glide path.

81. Program FTJPHL uses the data file produced as a part of the output of program FTJPRH (see paragraph 52 and Appendix E) as a point of departure. It will be recalled that the file does not imply that a tree actually exists at any specified distance from GZ; rather it specifies that if a tree of the specified type were at that distance, it would break off at the specified height. Thus, a file such as the one illustrated in Figure 7 describes only potential remnant heights of trees exhibiting a specific stem diameter, height, modulus of rupture, etc. Thus, one data set (i.e. the data provided on one Format 2 data form) will be a sufficient description only in those instances in which the forest is a single-species, even-aged stand. Many central European pine forests are of this kind. However, if the forest consists of many different species exhibiting many different stem sizes, Format 3 data forms will be required to adequately define the configuration of the vegetation crater.

82. In order for program FTJPHL to predict the number of remnants that must be removed, it must be provided with two basic items, in addition to the name of the remnant height file. The first item (see example of data form, Figure 21) of new information is the "Number of trees/100 m^2" in the stand described by the data form used to generate the special file. Methods of obtaining this value are discussed in detail in Appendix A.

83. The second item of new information is a specification of "landing zone design" that is desired. There are two options: circular and rectangular. A detailed rationale for this selection is given in Appendix F. A selection of landing zone design, coupled with the user-selected TZR and departure angle, in effect specifies the size and shape of the "clear volume" that must be provided to permit safe operation of the specified helicopter. Program FTJPHL first calculates the area of an annulus bounded by two distances from GZ. Using the example given in Figure 7, the first "annulus" is that bounded by

radii of 2.00 and 3.00 m. The program then compares the remnant height (0.2462 m in Figure 7) with the required ground clearance of the helicopter. For example, the UH-1B has a ground clearance of 0.3 m (Table 2). In this instance, the remnant height is less than the required ground clearance, so the program decides that no remnants need be cleared in this annulus.

84. This process is repeated sequentially. Thus, when the annulus bounded by radii of 4.0 and 5.0 m (0.3246 m in Figure 7) is examined, the program will "discover" that the remnant heights in that annulus exceed the ground clearance of the helicopter. The program then refers to the "Number of trees/100 m^2" value that has been provided by the user and calculates the number of such remnants that will probably occur in that annulus. Details of the mathematics involved in the procedure are given in Appendix F.

85. This procedure is repeated until the outer diameter of the annulus coincides with the diameter of the specified touch zone. For example, given the situation depicted in Figure 12, the last annulus evaluated in terms of hull clearance would be that one bounded by a radius of 15.0 m. At this point, successive annuli are evaluated in terms of the elevation of the glide path. In the example in Figure 12, the comparison of glide path altitude to remnant height in the annulus bounded by radii of 15.0 and 16.0 m would reveal that some remnants would intrude into the flight path. The number of such occurrences would then be calculated as described above. However, the comparison in the next annulus (i.e. that bounded by radii of 16.0 and 17.0 m) would reveal that the remnant heights were well below the glide path altitude, and thus no remnants in this annulus would have to be cleared.

86. The user's choice of one of the two landing zone design options (circular or rectangular) triggers a procedural change in the program calculations at the point at which the diameter of the annulus being evaluated equals the diameter of the touch zone. If the user selects a circular landing zone design, the procedure described in paragraph 85 above is continued as described. However, if the user selected a rectangular landing zone design, the program calculates the

area of only that portion of each annulus included between two parallel lines tangent to the edge of the touch zone. Thus, in the example in Figure F2, the program would calculate segments of annuli bounded by parallel lines 30 m apart. This is described in detail in Appendix F.

87. The product of the calculations is printed out as a table, as illustrated in Figure 22. From the tabulation in Figure 22 it can be seen that eight trees with diameters ranging from 50 to 75 cm will have to be cut out of the touch zone or glide path. Because the exact locations of the trees are not defined as input to the program (i.e., the structural cell concept is used to provide probabilistic tree diameter-tree spacing relations for the computations), the exact location of the trees to be cut cannot be identified as output. The output does scope the amount of the work to be done; therefore, the amount of equipment and number of men to be sent to the site can be estimated from the tabulation (Figure 22).

<u>Input requirements for FTJPHL</u>

88. Program FTJPHL must be provided with all of the items of data indicated on the data form (Figure 21), even though all of the notations are not actually used in the calculations. The headings in the following paragraphs refer to identically named items on the data form. An example of a filled-in data form is given in Figure 23.

89. <u>Sample No.</u> This code is not called for by the program. It is included on the data form only as an aid to the user; it helps him to keep his records straight.

90. <u>Helicopter.</u> The code designation <u>must</u> be that of one of the helicopters in the data file of helicopters. If the helicopter of interest to the user is not in the file already held by the computer, the user must add it to the file in accordance with the instructions given in Appendix B.

91. <u>TZR, m.</u> This value must be one of the two TZR's specified in the helicopter data file that describes the characteristics of the helicopter of interest. For example, if the helicopter is a UH-1B (Figure 23), the number in this item must be either 10.0, representing the minimum acceptable TZR (Table 2), or 15.0, representing the maximum TZR.

92. Departure angle, deg. This value may be any value between the minimum and maximum departure angles, inclusive, as listed in the helicopter data files. Thus, any angle between 22.0 and 75.0 deg (Table 2), inclusive, may be selected if the helicopter is a UH-1B.

93. Landing zone design. The user may select either a circular or rectangular design. The choice is usually dictated by considerations of wind speed and direction. If the winds over the site are consistently in one direction and exceed a speed of more than about 10 knots, it is usually best to choose the rectangular design. The rectangular design is an opening as wide as the diameter of the selected touch zone and as long as required to provide clearance for the selected departure angle. A schematic diagram of a rectangular HLZ design is given in Figure 24.

94. The advantage of this design is that it may significantly reduce the amount of land clearing necessary. The disadvantage is that it may constrain the helicopter to only one direction of approach. If the wind blows strongly and persistently from one direction, as in many regions dominated by trade winds, the helicopter may be forced to approach and depart against the wind for aerodynamic reasons; in this event, the rectangular design may clearly be the best option. On the other hand, if the wind velocities are very low, or the winds blow from a number of directions, it may be best to select the circular design, since it would allow approach and departure from any direction.

95. Remnant height file name. This entry is the code assigned by the user to the special output file created by program FTJPRH (see paragraph 52 and Appendix E). If programs FTJPRH and FTJPHL are run sequentially, as they will be in most instances, this code permits the computer to access the specific file that is relevant to the site under analysis.

96. Weapon yield, metric tons TNT. This value is not used in program FTJPHL. It is included in the record only as an aid to the user. The program simply accepts this number, stores it temporarily, and then prints it out as a part of the leader information in the printout (Figure 22). Any number is acceptable; if for some reason the user

does not want to include the actual weapon yield, he can give the program a nonsense number. However, that number will appear in line 5 of the printout.

97. Number of trees/100 m^2. This is a new item of information not previously furnished in this or the two preceding programs (i.e. FTHEL and FTJPRH). Instructions for obtaining this number are given in Appendix A.

98. Number of species. This number is not used in the calculations in this program. It is provided in the data form as an indication of the amount of space that must be set aside in computer memory to store the list of species names which follows.

99. Common names of species. These names are not used in the calculations in this program. They are simply stored temporarily in computer memory and printed out at the bottom of the printout (Figure 22). The species names are included primarily as supplementary information. If the printout is given to a field officer as a guide for operational action, the species names will provide him with some information that will be useful in planning the kinds and amounts of equipment required to perform the clearing job.

100. The number of entries in the species list must equal the number placed in the "Number of species" pigeonhole. If the species names are not known, nonsense words may be substituted for actual names, but those nonsense words will be reproduced in the printout.

Supplementary data form

101. In those sites exhibiting a number of different stem diameter classes and strength classes, such as many tropical forests,[10] it is necessary to run calculations on each combination of stem diameters and strengths in order to be certain that all contingencies have been examined. An example of a computer printout reflecting such a situation is given in Appendix C. In such cases, it is helpful, but not essential, to use a modification of the normal data form. Such a modified form is illustrated in Figure 25.

Instructions for use

102. Program FTJPHL is a conversational mode program. The program

requests data from the user in a particular sequence and will perform the programmed calculations only if all of the instructions are properly met. Figure 26 is an example of a product of program FTJPHL, as driven by the data provided in the data forms presented as Figure 27. The following discussion of procedure will be based on the situation presented in Figures 26 and 27.

103. The use of program FTJPHL is predicated on the assumption that the user has at least one completely filled-in data form. In the example, the user has three filled-in data forms (Figure 27).

104. The procedure is to call program FTJPHL into working storage and type RUN on the teletype to initiate the program. The program first presents the user with a list of helicopters that are in computer memory and asks the user to select one of them (A, Figure 26). In the example, the user selected the UH-1B Iroquois.

105. The program then asks the user to select one of two TZR's (B, Figure 26). These values have been extracted by the program from the appropriate helicopter data file (Table 2). As soon as the user provides this information, the program requests the user to select a departure angle (C). Any value between or including the two limiting values may be chosen. The limiting values have also been extracted by the program from the appropriate helicopter data file (Table 2). When this answer has been provided, the program asks whether the user wants to examine a rectangular or circular landing zone (D). In the example (Figure 26), the user selected the rectangular design (Figure 24).

106. At this point, the computer asks for the name of the input file that contains "the distances and remnant heights" (E). These are the special files produced by the use of Formats 2 and 3 in program FTJPRH (see paragraph 52 and Appendix E). It is absolutely essential that the identification be accurate, since the name is in effect the address of the appropriate file in disc storage. Without the name, the program cannot find the proper file. In the example (Figure 26), the user identified the file as RHF6, which is the name of the space set aside to store the output of program FTJPRH.

107. The program now asks for the weapon yield (F). When this has been provided, the program requests the number of trees per 100 m^2 (G) that occur on the site and are characterized by a specific strength class and diameter class. Both the strength class number and the diameter class number are derived from file RHF6. It will be recalled that the file is headed by a single record (Figures E2 and E3) that includes numbers for stem diameter, tree height, and strength class. The program interprets the first of these in terms of stem diameter class and reads the second and third numbers (maximum tree height and stem diameter class) directly. These values appear as a part of the leader information on the printout of program FTJPHL (sheet 2, Figure 26). Suggestions and procedures for obtaining data concerning the number of tree stems on a site are provided in Appendix A.

108. The program then asks for the number of species represented by the data just provided (H). In the example, the program asks for the number of tree species exhibiting strength class 5 and diameter class 8, because those were the criteria used in the data file. It is important that the number of species cited in response to this question match the actual number listed in response to the next program request (see paragraphs 100 and 111).

109. The next program request is a sequence (I), the length of which depends on the number of species which the user has just provided. The program will repeat the question (What is the common name for Species No. ...?) exactly the same number of times as the number of species provided. Thus, in the example, the question is asked twice.

110. At this point, all of the program requests have been satisfied. The program then prints out a line of asterisks to indicate that it is making the necessary computations. When these are complete, it prints out the display shown at the top of sheet 2, Figure 26.

111. As soon as that has been accomplished, the program asks if the user wants to run another remnant height file (J). The user must reply by typing either YES or NO. In the example, the user typed NO. In this event, the program then lists five options (K) and asks the user to select one of them. In the example, the user selected option 1 (run

another departure angle and same TZR). Given this option, the program asks for the new departure angle (L) and a landing zone design (M). As soon as these have been provided, the program performs the computations with the new data and prints out the results (middle of sheet 3, Figure 26).

112. When this action is complete, the program again asks if the user wants to run another remnant height file. If the answer is again NO (as in the example), the program repeats the list of options and again asks for a selection. Let us suppose that the user opts to run the same data but for a different helicopter, as in the example at the bottom of sheet 3, Figure 26.

113. In this event, the program requests the identification number of the new helicopter and the new TZR relevant to the specified helicopter type (N). After this is provided, the program asks for a new departure angle and landing zone design (O). The program then makes the computations with the new data and prints out the product (bottom of sheet 4, Figure 26).

114. At this point, the program again asks if the user wants to run another remnant height file (P). In the example, the user typed NO and selected option 5 (Q) in response to the list of options which the program has presented. Other options could have been selected; examples are provided in Appendix C.

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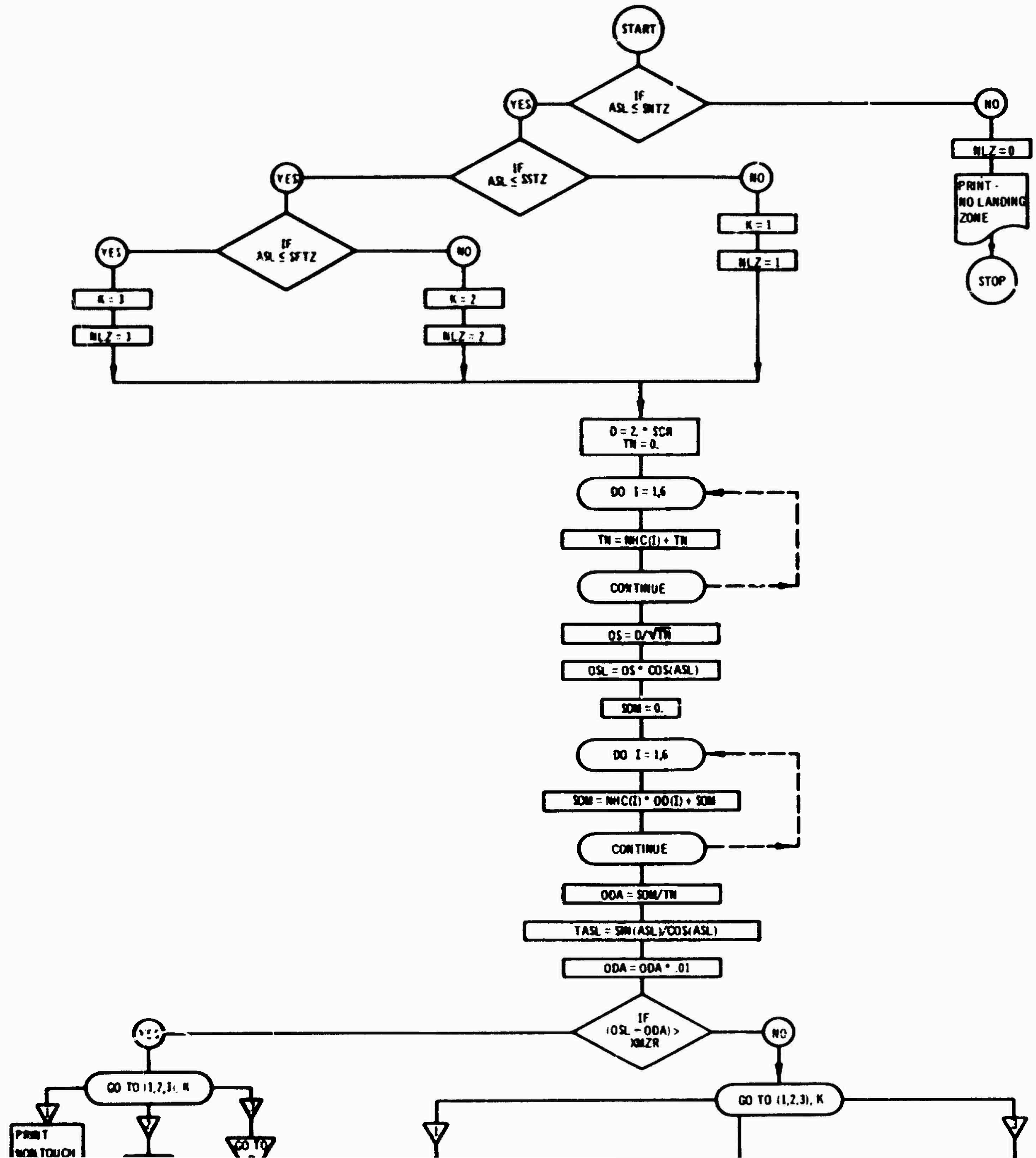
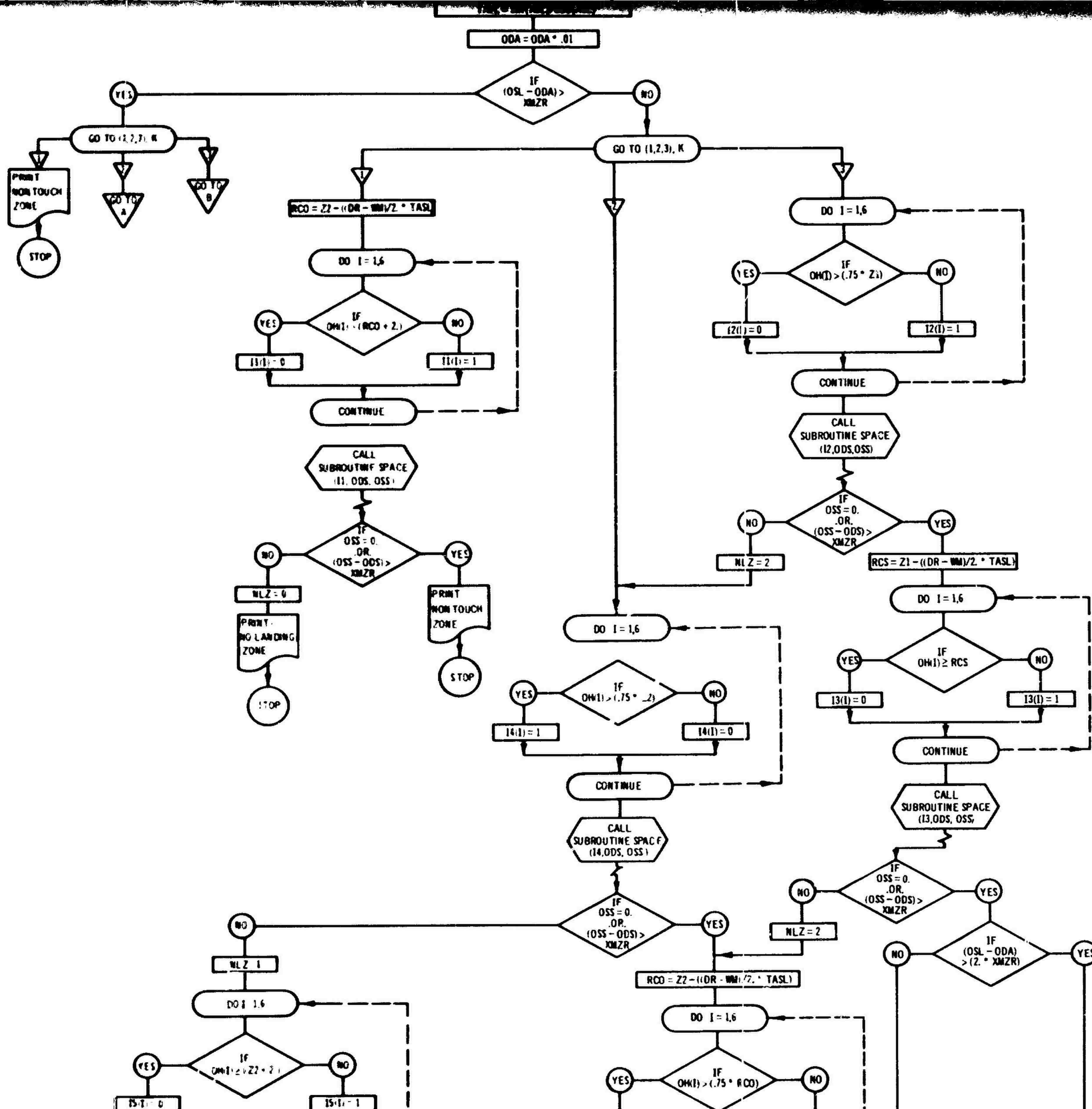
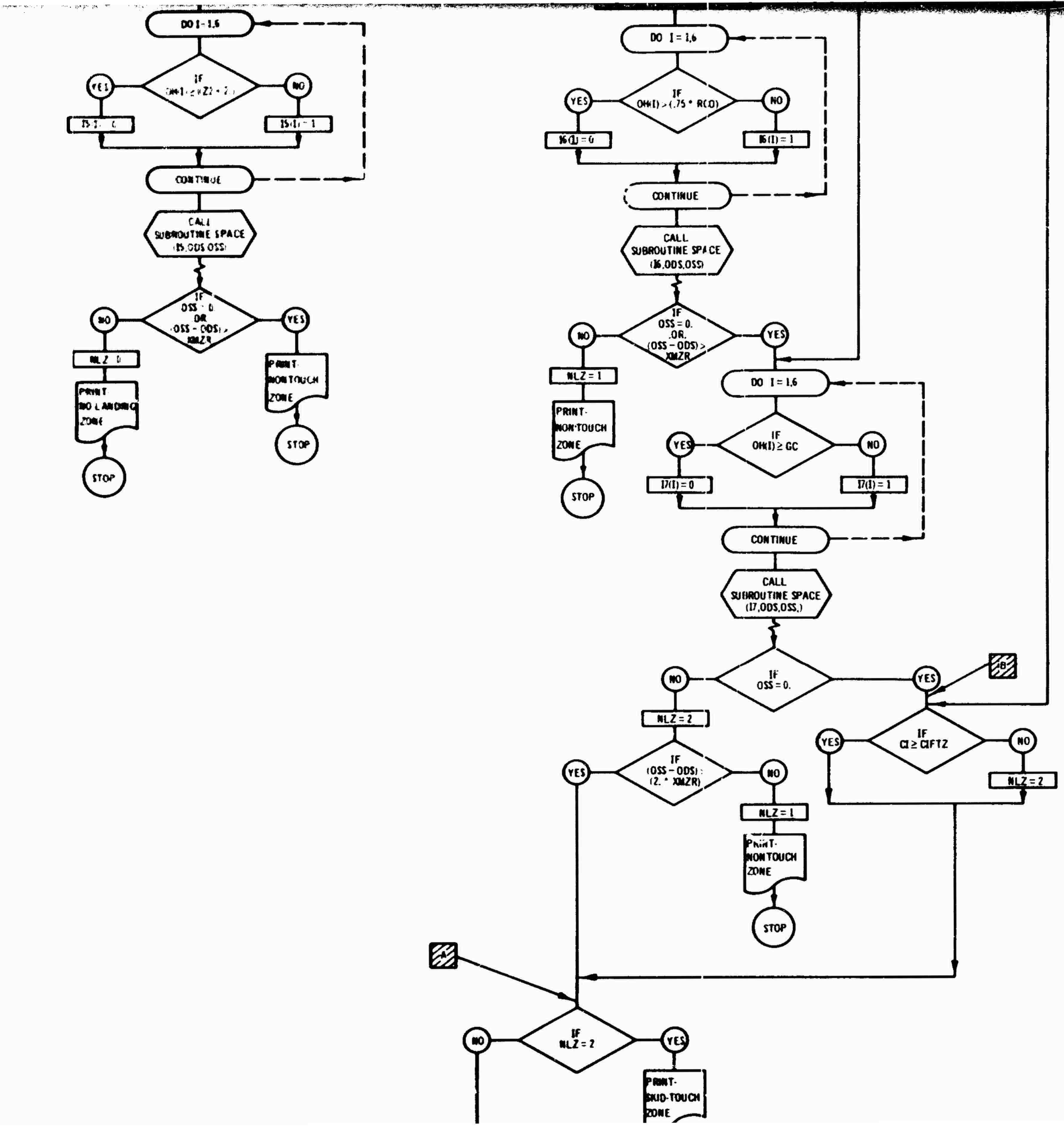

START
IF ASL ≤ SNTZ
YES
NO
NLZ = 0
PRINT - NO LANDING ZONE
STOP
IF ASL ≤ SSTZ
K = 1
NLZ = 1
IF ASL ≤ SFTZ
K = 3
NLZ = 3
K = 2
NLZ = 2
D = 2. * SCR
TN = 0.
DO I = 1,6
TN = NHC(I) + TN
CONTINUE
OS = D/√TN
OSL = OS * COS(ASL)
SOM = 0.
DO I = 1,6
SOM = NHC(I) * OD(I) + SOM
CONTINUE
ODA = SOM/TN
TASL = SIN(ASL)/COS(ASL)
ODA = ODA * .01
IF (OSL - ODA) > XMZR
GO TO (1,2,3), K
GO TO (1,2,3), K
PRINT NON TOUCH
GO TO

2

1



ODA = ODA * .01
IF (OSL – ODA) > XMZR
YES
NO
GO TO (1,2,3), K
PRINT NON TOUCH ZONE
STOP
GO TO A
GO TO B
RCO = Z2 – ((DR – WM)/2. * TASL)
DO I = 1,6
IF OH(I) > (RCO + 2.)
I1(I) = 0
I1(I) = 1
CONTINUE
CALL SUBROUTINE SPACE (I1, ODS, OSS)
IF OSS = 0. .OR. (OSS – ODS) > XMZR
NLZ = 0
PRINT NO LANDING ZONE
PRINT NON TOUCH ZONE
STOP
IF OH(I) > (.75 * Z2)
I4(I) = 1
I4(I) = 0
CALL SUBROUTINE SPACE (I4,ODS, OSS)
NLZ = 1
IF OH(I) ≥ (Z2 + 2.)
I5(I) = 0
I5(I) = 1
IF OH(I) > (.75 * Z1)
I2(I) = 0
I2(I) = 1
CALL SUBROUTINE SPACE (I2,ODS,OSS)
NLZ = 2
RCS = Z1 – ((DR – WM)/2. * TASL)
IF OH(I) ≥ RCS
I3(I) = 0
I3(I) = 1
CALL SUBROUTINE SPACE (I3,ODS, OSS)
IF (OSL – ODA) > (2. * XMZR)
RCO = Z2 – ((DR – WM)/2. * TASL)
IF OH(I) > (.75 * RCO)



DO I = 1,6
IF OH(I) > (.75 * R(I))
YES
NO
I6(I) = 0
I6(I) = 1
CONTINUE
CALL SUBROUTINE SPACE (I6,ODS,OSS)
IF OSS = 0. .OR. (OSS – ODS) > XMZR
NO
YES
NLZ = 1
PRINT-NON-TOUCH ZONE
STOP
DO I = 1,6
IF OH(I) ≥ GC
I7(I) = 0
I7(I) = 1
CONTINUE
CALL SUBROUTINE SPACE (I7,ODS,OSS,)
IF OSS = 0.
NLZ = 2
IF (OSS – ODS) ≥ (2. * XMZR)
NLZ = 1
PRINT-NON TOUCH ZONE
STOP
IF CI ≥ CIFTZ
NLZ = 2
B
A
IF NLZ = 2
PRINT-SKID-TOUCH ZONE

3

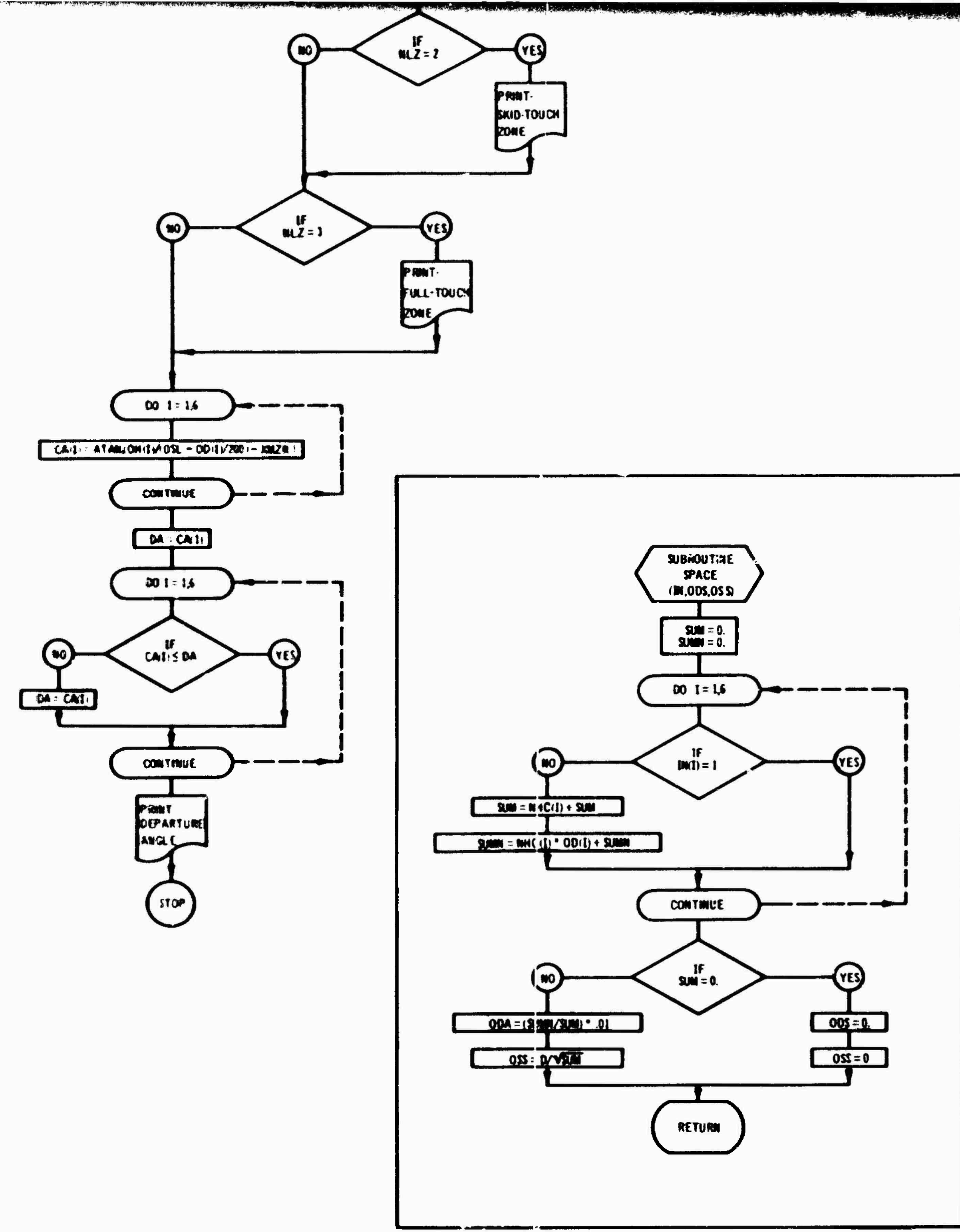
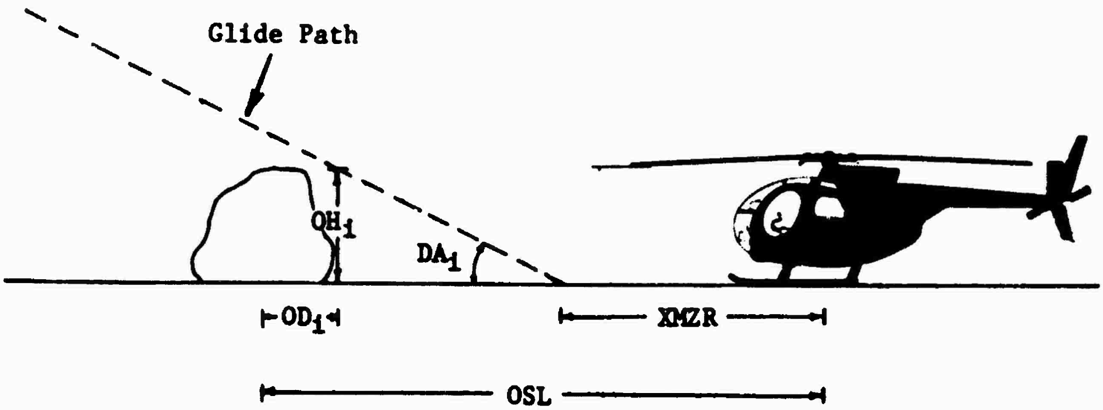


Figure 1. Flow chart of computer program FTHEL



$$DA_i = \tan^{-1}\left(\frac{OH_i}{OSL - \frac{OD_i}{100} - XMZR}\right)$$

where:

i = subscript indicating height class (1-6)

DA_i = minimum departure angle for height class i, deg

OH_i = maximum height of single feature in height class i, m

OSL = spacing of microrelief in all height classes, m

OD_i = average diameter of features in height class i, cm

$XMZR$ = minimum touch zone radius, m

Figure 2. Diagram showing determination of minimum departure angle

A. Microrelief Feature Data

	Height Class I	Height Class II	Height Class III	Height Class IV	Height Class V	Height Class VI
Height of upper limit of each class	____	____	____	____	____	____
Average diameter of microrelief features in each class	____	____	____	____	____	____
Number of features in each class	____	____	____	____	____	____

B. Additional Terrain Descriptors

________ Cone index, psi

________ Radius of largest sample cell of microrelief features that are homogeneously distributed, m

________ Ground slope, deg

Figure 3. Data input form for program FTHEL

A. Microrelief Feature Data

	Height Class I	Height Class II	Height Class III	Height Class IV	Height Class V	Height Class VI
Height of upper limit of each class	C.1	0.5	2.0	2.5	3.2	4.5
Average diameter of microrelief features in each class	5	10	28	30	65	50
Number of features in each class	30	23	20	18	18	20

B. Additional Terrain Descriptors

100 Cone index, psi

50 Radius of largest sample cell of microrelief features that are homogeneously distributed, m

2 Ground slope, deg

Figure 4. Example of completed form for input data to computer program FTHEL

```
THE FOLLOWING HELICOPTER FILES ARE AVAILABLE:
   1. UH-1H, IROQUOIS
   2. UH-1B, IROQUOIS
   3. OH-6A, CAYUSE
   4. CH-47A, CHINOOK
   5. CH-47C, CHINOOK

 SELECT A HELICOPTER AND TYPE ITS NUMBER.                          A
=4

SELECT   21.00 OR   26.00 METERS AS TOUCH ZONE RADIUS.

=26                                                                  B

 INPUT THE MAXIMUM HEIGHT (M) THAT OCCURS IN EACH OF THE SIX
 MICRORELIEF HEIGHT CLASSES  (BEGIN WITH THE LARGEST HEIGHT
 CLASS).

=4.5,3.2,2.5,2.0,.5,.1                                          C

 INPUT THE AVERAGE OBSTACLE DIAMETER (CM) FOR EACH MICRORELIEF
 HEIGHT CLASS  (BEGIN WITH THE LARGEST HEIGHT CLASS).

=50,65,30,28,10,5                                                  D

 INPUT THE NUMBER OF MICRORELIEF FEATURES IN EACH HEIGHT CLASS
 INCLUDED IN THE SAMPLE CELL AREA  (BEGIN WITH THE LARGEST
 CLASS).
                                                                    E
=28,18,18,20,23,30

 INPUT THREE VALUES:  THE CONE INDEX (SOIL STRENGTH IN PSI),
 LARGEST SAMPLE CELL RADIUS (M), AND GROUND SLOPE (DEG).

=100,50,2                                                  F
```

Figure 5. Sample run of the computer program FTHEL (sheet 1 of 3)

LANDING ZONES WILL BE CLASSIFIED AS:
FULL TOUCH (FTZ)
SKID TOUCH (STZ)
NON-TOUCH (NTZ)
NO LANDING (NLZ)

G

THE PREDICTIONS WHICH ARE MADE IMPLY THE FOLLOWING:
IF FTZ PREDICTED, FTZ, STZ, AND NTZ ARE POSSIBLE.
IF STZ PREDICTED, STZ AND NTZ ARE POSSIBLE.
IF NTZ PREDICTED, ONLY NTZ IS POSSIBLE.
IF NLZ PREDICTED, THE SITE IS UNACCEPTABLE AS A LANDING ZONE OF ANY KIND.

* * * * * * *

WOULD YOU LIKE TO SEE THE DEFINITIONS OF THE LANDING ZONE CLASSIFICATIONS ? (TYPE YES OR NO)

=YES

H

* * * * * * *

FULL TOUCH ZONE (FTZ) - A LANDING ZONE IN WHICH AT LEAST ONE HELICOPTER CAN LAND AND TAKE OFF SAFELY. AN FTZ MUST BE CAPABLE OF SUPPORTING A MISSION WHICH REQUIRES A LANDING WITH THE WEIGHT OF A FULLY LOADED AIRCRAFT RESTING COMPLETELY ON THE GROUND. OF ALL THE LANDING ZONE CLASSIFICATIONS, TERRAIN SPECIFICATIONS ARE MOST STRINGENT FOR AN FTZ.

Figure 5 (sheet 2 of 3)

SKID TOUCH ZONE (STZ) - AN STZ IS DEFINED AS AN AREA IN WHICH AT LEAST ONE HELICOPTER CAN REST WITH ONE SKID OR SET OF WHEELS ON THE GROUND, BUT WITH THE WEIGHT OF THE HELICOPTER SUPPORTED LARGELY BY THE ROTOR. THIS LESS STABLE CONFIGURATION RESTRICTS THE LOADING AND UNLOADING PROCESS AND IS MORE DIFFICULT FOR THE PILOT THAN LANDING ON AN FTZ. SOFT SOIL IS OFTEN THE REASON FOR A LANDING ZONE CLASSIFICATION OF STZ, AND THE IMPACT OF THIS ON THE MOBILITY OF TROOPS AND VEHICLES ARRIVING FOR LOADING OR UNLOADING SHOULD BE CONSIDERED.

NON-TOUCH ZONE (NTZ) - GROUND FEATURES SUCH AS STEEP SLOPES, MICRORELIEF (BOULDERS, DITCHES, ETC.), AND VEGETATION CAN RESTRICT A SITE TO AN NTZ. AN NTZ WILL PERMIT AT LEAST ONE HELICOPTER TO APPROACH, HOVER WITHIN SIGHT OF THE GROUND SURFACE, AND DEPART. AN NTZ IS SUFFICIENT FOR DISCHARGE OF TROOPS AND EQUIPMENT, BUT LOADING IS VERY DIFFICULT.

NO LANDING ZONE (NLZ) - AN NLZ CLASSIFICATION IMPLIES SITE CONDITIONS ARE SUCH THAT A HELICOPTER CANNOT APPROACH NEAR ENOUGH TO THE GROUND TO LOAD OR DISCHARGE TROOPS OR EQUIPMENT, AND CONSEQUENTLY IS UNSUITABLE FOR AN HLZ OF ANY TYPE.

* * * * * * *

I

THE SITE CONDITIONS SPECIFIED WERE EVALUATED FOR THE CH-47A CHINOOK, AND THE RESULTS ARE AS FOLLOWS:

1. THE LANDING ZONE CLASSIFICATION IS NTZ.
2. FOR THE NTZ CLASSIFICATION, NO DEPARTURE ANGLE IS COMPUTED.

Figure 5 (sheet 3 of 3)

Vegetation Input Data Format 1

Site ______________________________

Weapon yield __________ Output file name __________

Item	Value
1. Common name (not to exceed 39 characters)	________
2. Tree identification number (1-999)	________
3. Modulus of rupture, dynes/cm^2*	________
4. Young's modulus, dynes/cm^2*	________
5. Wood density (green), g/cm^3,	________
OR	
Specific gravity and	________
Moisture content, %	________
6. Stem diameter, cm, measured at height of 1 m above stem base	________
7. Maximum tree height, m to nearest tenth	________
8. Tree positions (select one method from the following)	
a. Calculate at 1-m intervals from GZ	YES ______ NO ______
b. Several locations of this tree at discrete distances from GZ, m; enter distances in ascending order (maximum of 115 positions)	No. locations: ______ Distances: ________ ________ ________ ________ ________ ________
c. Locations of this tree defined by XY-coordinates; enter coordinates of GZ first, then follow with X and Y for each tree position (maximum of 115 positions)	No. locations: ______ Coordinates: ________ ________ ________ ________ ________ ________

* These values are quite large, and it is much easier to enter the value as a number with an exponent (as a power of 10). In computer language, E represents the term, power of 10, e.g.

Modulus of rupture = 524400000. = 5.244E+8

Figure 6. Data input form for Format 1 for program FTJPRH

Distance from GZ, m	Predicted remnant height, m
1·0000	0·0001
2·0000	0·0001
3·0000	0·2462
4·0000	0·2940
5·0000	0·3246
6·0000	0·3461
7·0000	0·3643
8·0000	0·3827
9·0000	0·4037
10·0000	0·4284
11·0000	0·4577
12·0000	0·4919
13·0000	0·5311
14·0000	0·5748
15·0000	0·6224
16·0000	0·6733
17·0000	0·7276
18·0000	0·7866
19·0000	0·8526
20·0000	0·9283
21·0000	1·0156
22·0000	1·1138
23·0000	1·2208
24·0000	1·3383
25·0000	1·4837
26·0000	1·7053
27·0000	2·0904
28·0000	2·7458
29·0000	3·7297
30·0000	4·9356
31·0000	5·0000

Figure 7. Listing of vegetation profile as it appears in the output file

Vegetation Input Data Format 2*

Site ____________________

Weapon yield __________ Output file name __________

Item	Value
1. Maximum wood strength class occurring in the site	________
2. Maximum stem diameter, cm, in the maximum wood strength class	________
3. Maximum tree height, m to nearest tenth, in the maximum wood strength class	________

* This format uses maximum conditions present in a site and evaluates the site as a prospective landing zone by comparing the vertical clearances required by the landing of a helicopter to the vegetation profile of the clearing that results where these extreme conditions exist.

Figure 8. Data input form for Format 2 for program FTJPRH

Vegetation Input Data Format 3

Site ____________________

Weapon yield __________ Output file name __________

Maximum Stem Diameter and Tree Height: Diameter Class		Wood Strength Class 1	2	3	4	5	6
1	Diam, cm						
	Height, m						
2	Diam, cm						
	Height, m						
3	Diam, cm						
	Height, m						
4	Diam, cm						
	Height, m						
5	Diam, cm						
	Height, m						
6	Diam, cm						
	Height, m						
7	Diam, cm						
	Height, m						
8	Diam, cm						
	Height, m						
9	Diam, cm						
	Height, m						

DIAMETER CLASS RANGES

Diameter Class	Strength Class 1	2	3	4	5	6
1	0-7	0-7	0-7	0-7	0-7	0-7
2	7-9	7-10	7-10	7-10	7-10	7-10
3	9-14	10-14	10-15	10-15	10-15	10-15
4	14-18	14-19	15-20	15-20	15-20	15-20
5	18-23	19-24	20-24	20-25	20-25	20-25
6	23-34	24-36	24-37	25-38	25-38	25-38
7	34-46	36-48	37-49	38-50	38-50	38-51
8	46-68	48-72	49-73	50-75	50-75	51-76
9	68-85	72-91	73-91	75-94	75-94	76-95

Figure 9. Data input form for Format 3 for program FTJPRH

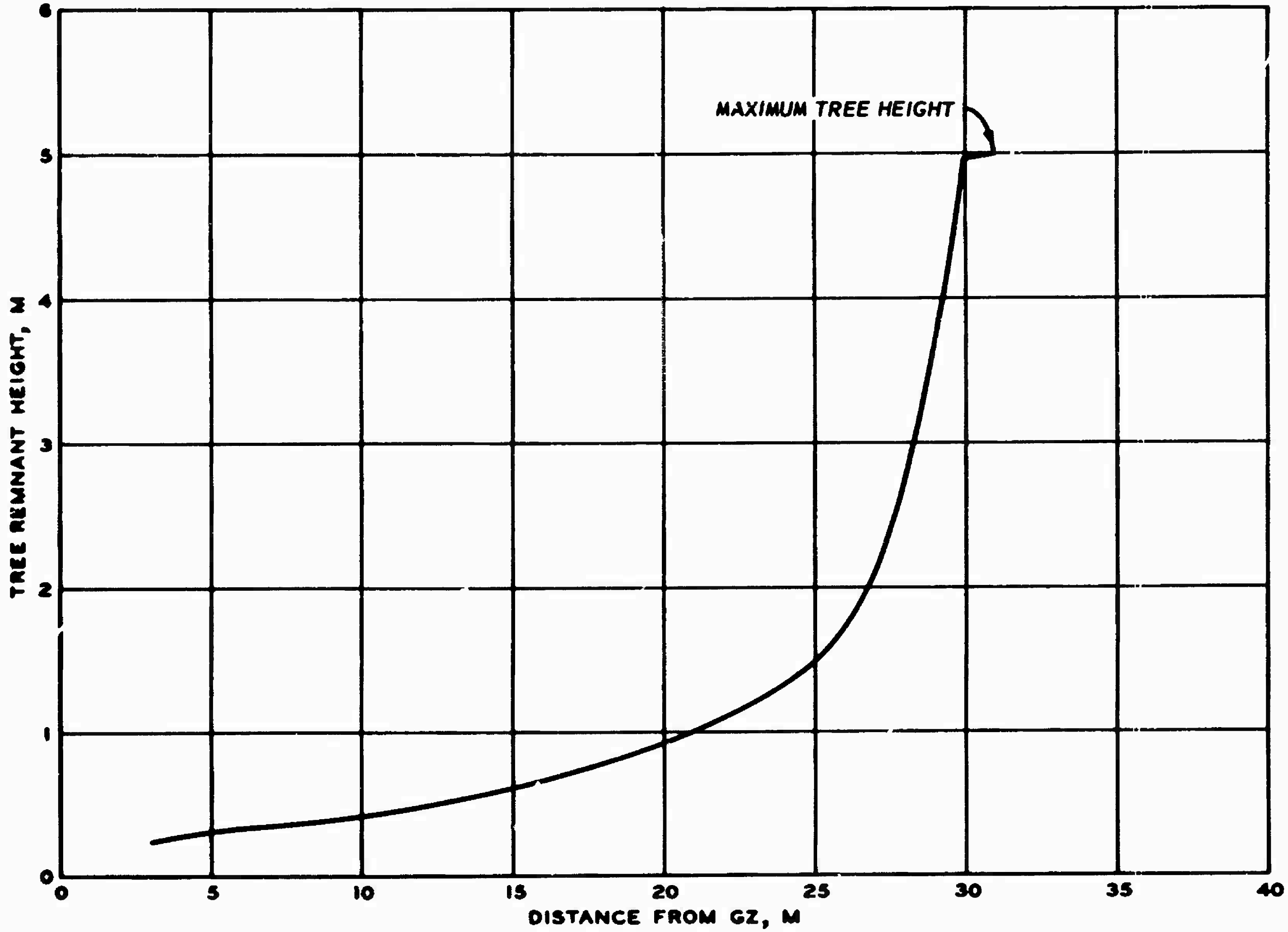


Figure 10. Plot of vegetation "crater" profile formed by tree remnants

* *

HELICOPTER	UH-1H
DEPARTURE ANGLE (DEG)	42.0
RADIUS OF TOUCH ZONE (M)	15.0
WEAPON YIELD (METRIC TONS, TNT)	6.6
WOOD STRENGTH CLASS	5
MAXIMUM TREE DIAMETER (CM)	15.
MAXIMUM TREE HEIGHT (M)	4.

****

DISTANCE FROM GROUND ZERO (M)	TREE REMNANT HEIGHT (M)	HEIGHT OF GLIDE PATH (M)
3.00	0.37	0.39
4.00	0.48	0.39
5.00	0.57	0.39
6.00	0.64	0.39
7.00	0.69	0.39
8.00	0.73	0.39
9.00	0.76	0.39
10.00	0.80	0.39
11.00	0.84	0.39
12.00	0.89	0.39
13.00	0.94	0.39
14.00	1.01	0.39
15.00	1.09	0.39
16.00	1.18	1.29
17.00	1.28	2.19
18.00	1.39	3.09
19.00	1.55	3.99
20.00	1.82	4.89
21.00	2.30	5.79
22.00	3.12	6.69
23.00	4.00 *	7.59

* MAXIMUM TREE HEIGHT

* *

Figure 11. Example of output table providing comparison between remnant heights and glide paths

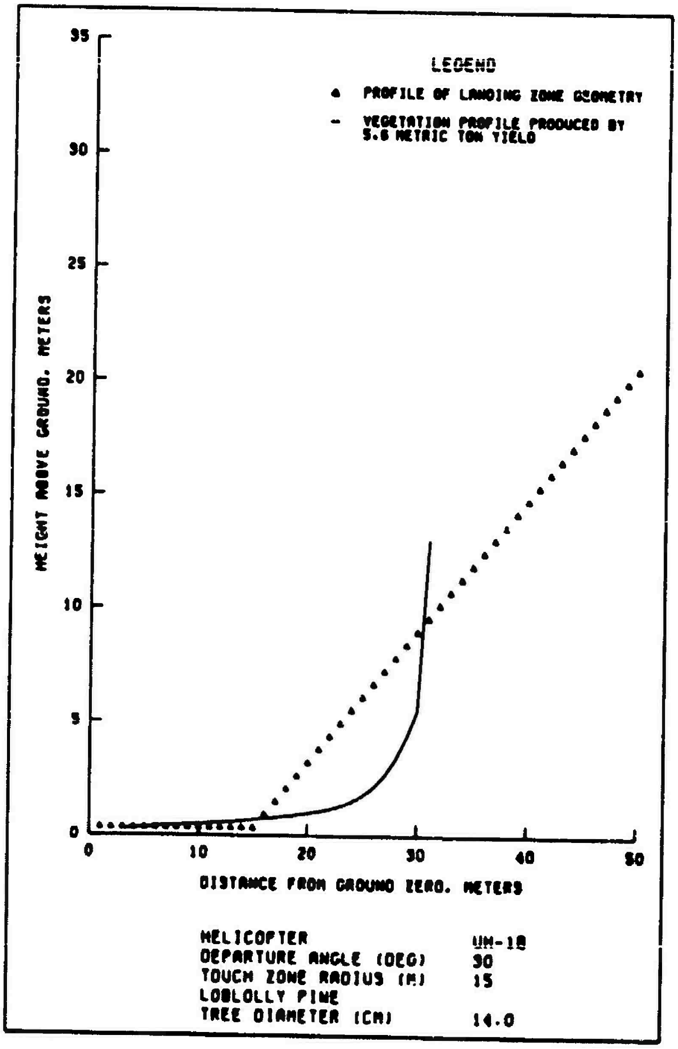


Figure 12. Graphic presentation of landing zone evaluation prepared on an off-line plotting device

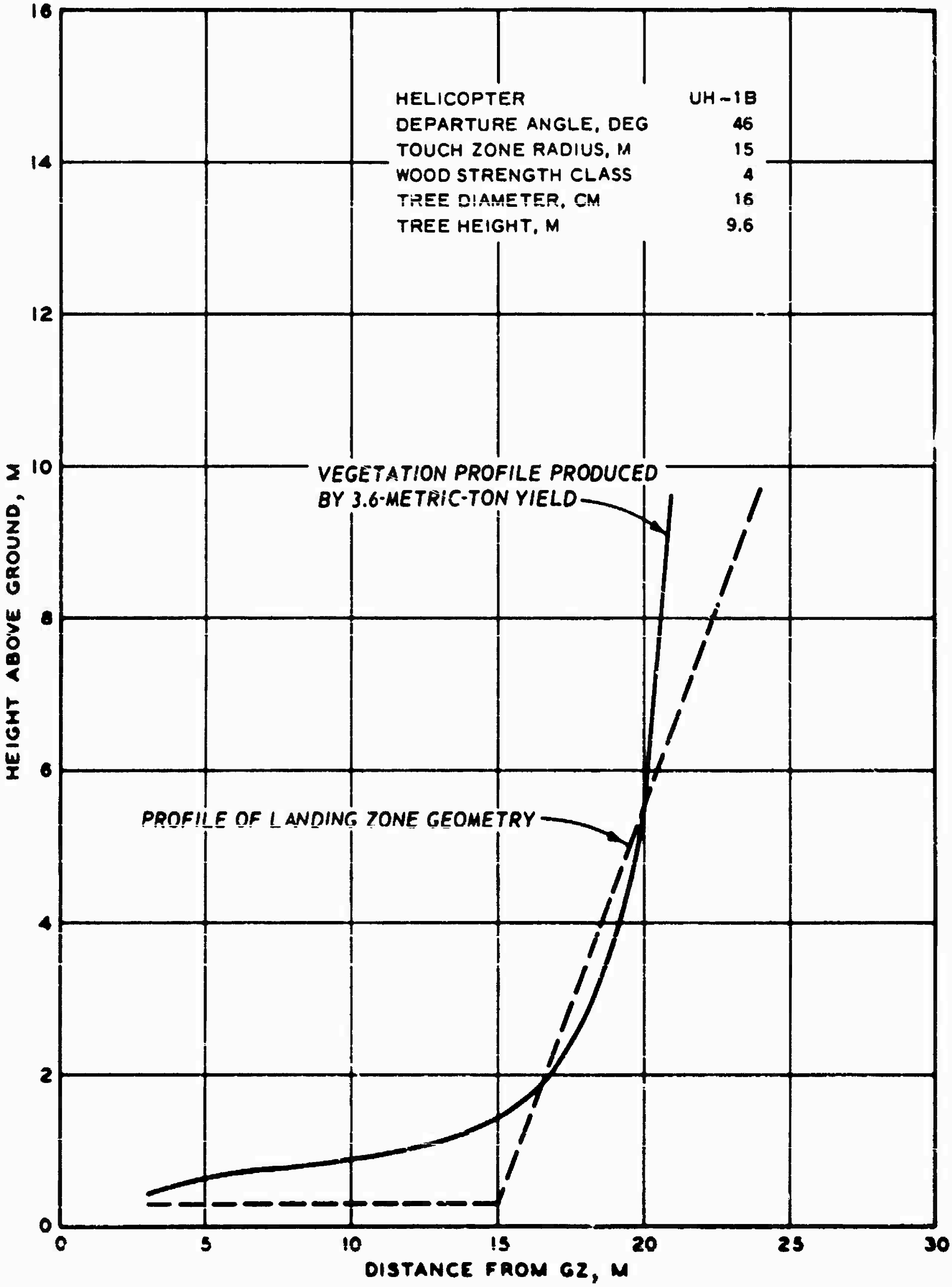
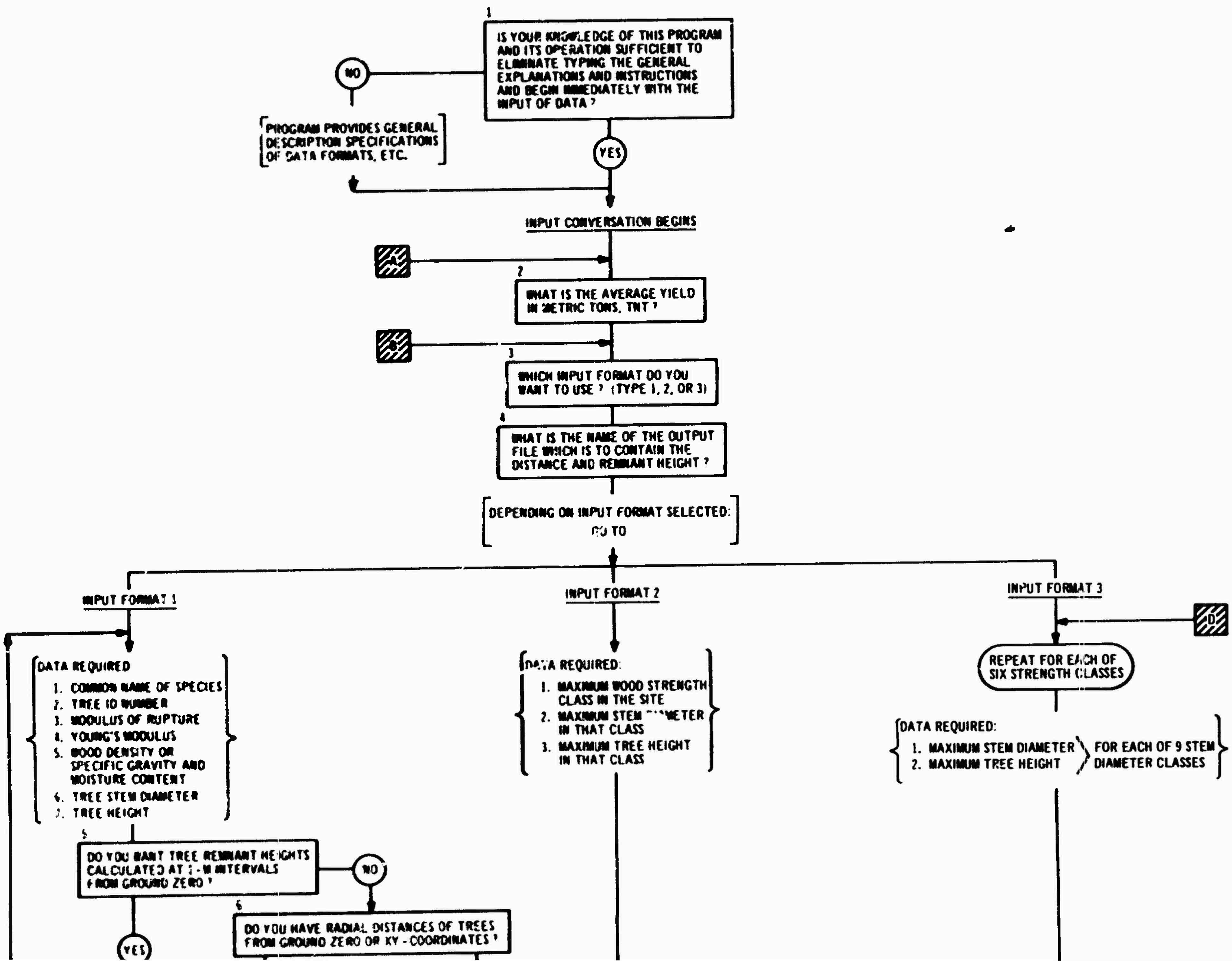
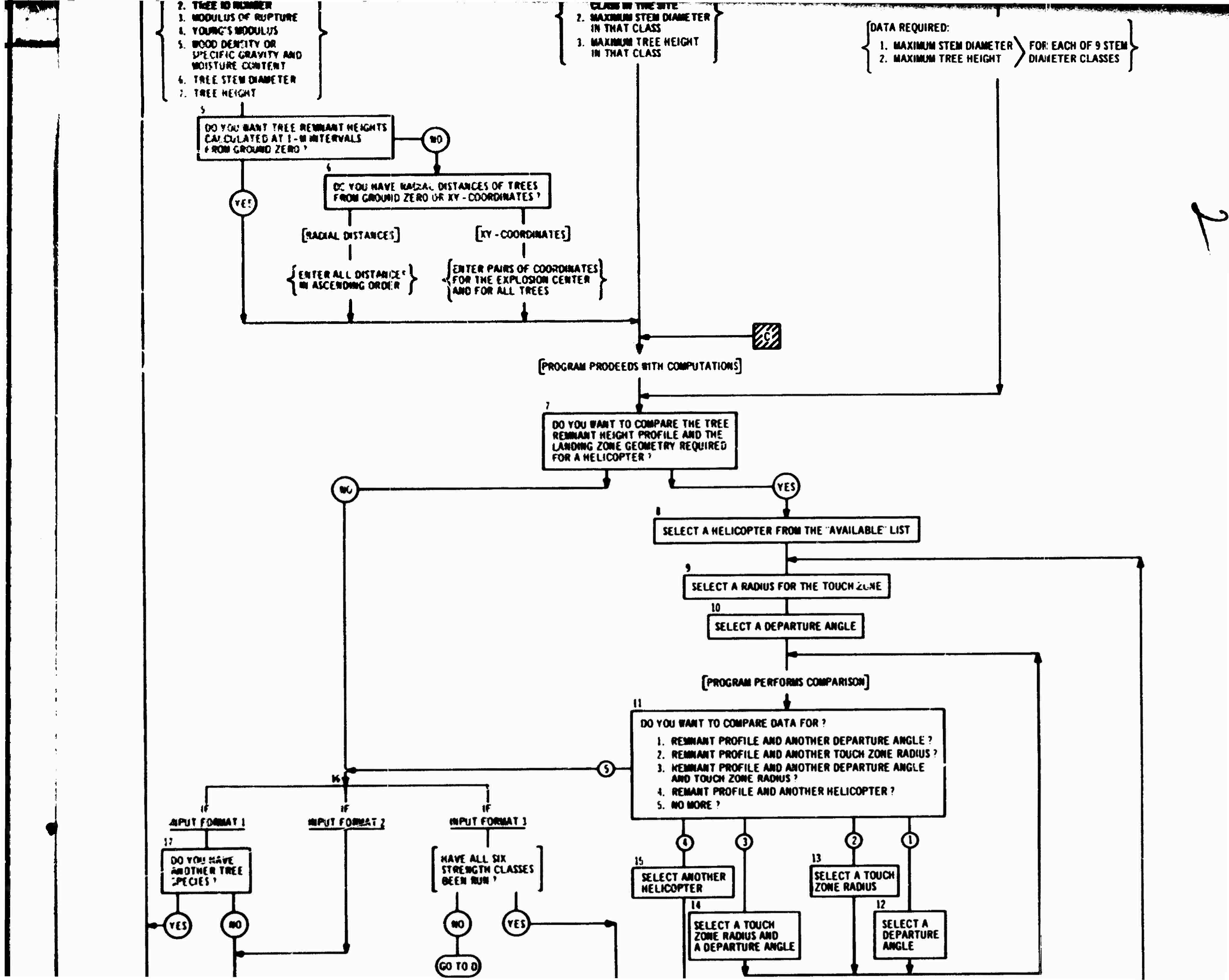


Figure 13. Manually produced plot of landing zone evaluation


1
IS YOUR KNOWLEDGE OF THIS PROGRAM AND ITS OPERATION SUFFICIENT TO ELIMINATE TYPING THE GENERAL EXPLANATIONS AND INSTRUCTIONS AND BEGIN IMMEDIATELY WITH THE INPUT OF DATA?
NO
PROGRAM PROVIDES GENERAL DESCRIPTION SPECIFICATIONS OF DATA FORMATS, ETC.
YES
INPUT CONVERSATION BEGINS
A
2
WHAT IS THE AVERAGE YIELD IN METRIC TONS, TNT?
B
3
WHICH INPUT FORMAT DO YOU WANT TO USE? (TYPE 1, 2, OR 3)
4
WHAT IS THE NAME OF THE OUTPUT FILE WHICH IS TO CONTAIN THE DISTANCE AND REMNANT HEIGHT?
DEPENDING ON INPUT FORMAT SELECTED: GO TO
INPUT FORMAT 1
DATA REQUIRED
1. COMMON NAME OF SPECIES
2. TREE ID NUMBER
3. MODULUS OF RUPTURE
4. YOUNG'S MODULUS
5. WOOD DENSITY OR SPECIFIC GRAVITY AND MOISTURE CONTENT
6. TREE STEM DIAMETER
7. TREE HEIGHT
5
DO YOU WANT TREE REMNANT HEIGHTS CALCULATED AT 1-M INTERVALS FROM GROUND ZERO?
NO
YES
6
DO YOU HAVE RADIAL DISTANCES OF TREES FROM GROUND ZERO OR XY-COORDINATES?
INPUT FORMAT 2
DATA REQUIRED:
1. MAXIMUM WOOD STRENGTH CLASS IN THE SITE
2. MAXIMUM STEM DIAMETER IN THAT CLASS
3. MAXIMUM TREE HEIGHT IN THAT CLASS
INPUT FORMAT 3
D
REPEAT FOR EACH OF SIX STRENGTH CLASSES
DATA REQUIRED:
1. MAXIMUM STEM DIAMETER
2. MAXIMUM TREE HEIGHT
FOR EACH OF 9 STEM DIAMETER CLASSES


2
2. TREE ID NUMBER
3. MODULUS OF RUPTURE
4. YOUNG'S MODULUS
5. WOOD DENSITY OR SPECIFIC GRAVITY AND MOISTURE CONTENT
6. TREE STEM DIAMETER
7. TREE HEIGHT
CLASS IN THE SITE
2. MAXIMUM STEM DIAMETER IN THAT CLASS
3. MAXIMUM TREE HEIGHT IN THAT CLASS
DATA REQUIRED:
1. MAXIMUM STEM DIAMETER
2. MAXIMUM TREE HEIGHT
FOR EACH OF 9 STEM DIAMETER CLASSES
5
DO YOU WANT TREE REMNANT HEIGHTS CALCULATED AT 1-M INTERVALS FROM GROUND ZERO ?
NO
YES
6
DO YOU HAVE RADIAL DISTANCES OF TREES FROM GROUND ZERO OR XY-COORDINATES ?
[RADIAL DISTANCES]
[XY-COORDINATES]
ENTER ALL DISTANCES IN ASCENDING ORDER
ENTER PAIRS OF COORDINATES FOR THE EXPLOSION CENTER AND FOR ALL TREES
C
[PROGRAM PROCEEDS WITH COMPUTATIONS]
7
DO YOU WANT TO COMPARE THE TREE REMNANT HEIGHT PROFILE AND THE LANDING ZONE GEOMETRY REQUIRED FOR A HELICOPTER ?
NO
YES
8
SELECT A HELICOPTER FROM THE "AVAILABLE" LIST
9
SELECT A RADIUS FOR THE TOUCH ZONE
10
SELECT A DEPARTURE ANGLE
[PROGRAM PERFORMS COMPARISON]
11
DO YOU WANT TO COMPARE DATA FOR ?
1. REMNANT PROFILE AND ANOTHER DEPARTURE ANGLE ?
2. REMNANT PROFILE AND ANOTHER TOUCH ZONE RADIUS ?
3. REMNANT PROFILE AND ANOTHER DEPARTURE ANGLE AND TOUCH ZONE RADIUS ?
4. REMANT PROFILE AND ANOTHER HELICOPTER ?
5. NO MORE ?
5
4
3
2
1
15
SELECT ANOTHER HELICOPTER
14
SELECT A TOUCH ZONE RADIUS AND A DEPARTURE ANGLE
13
SELECT A TOUCH ZONE RADIUS
12
SELECT A DEPARTURE ANGLE
16
IF INPUT FORMAT 1
IF INPUT FORMAT 2
IF INPUT FORMAT 3
17
DO YOU HAVE ANOTHER TREE SPECIES ?
YES
NO
HAVE ALL SIX STRENGTH CLASSES BEEN RUN ?
NO
YES
GO TO D

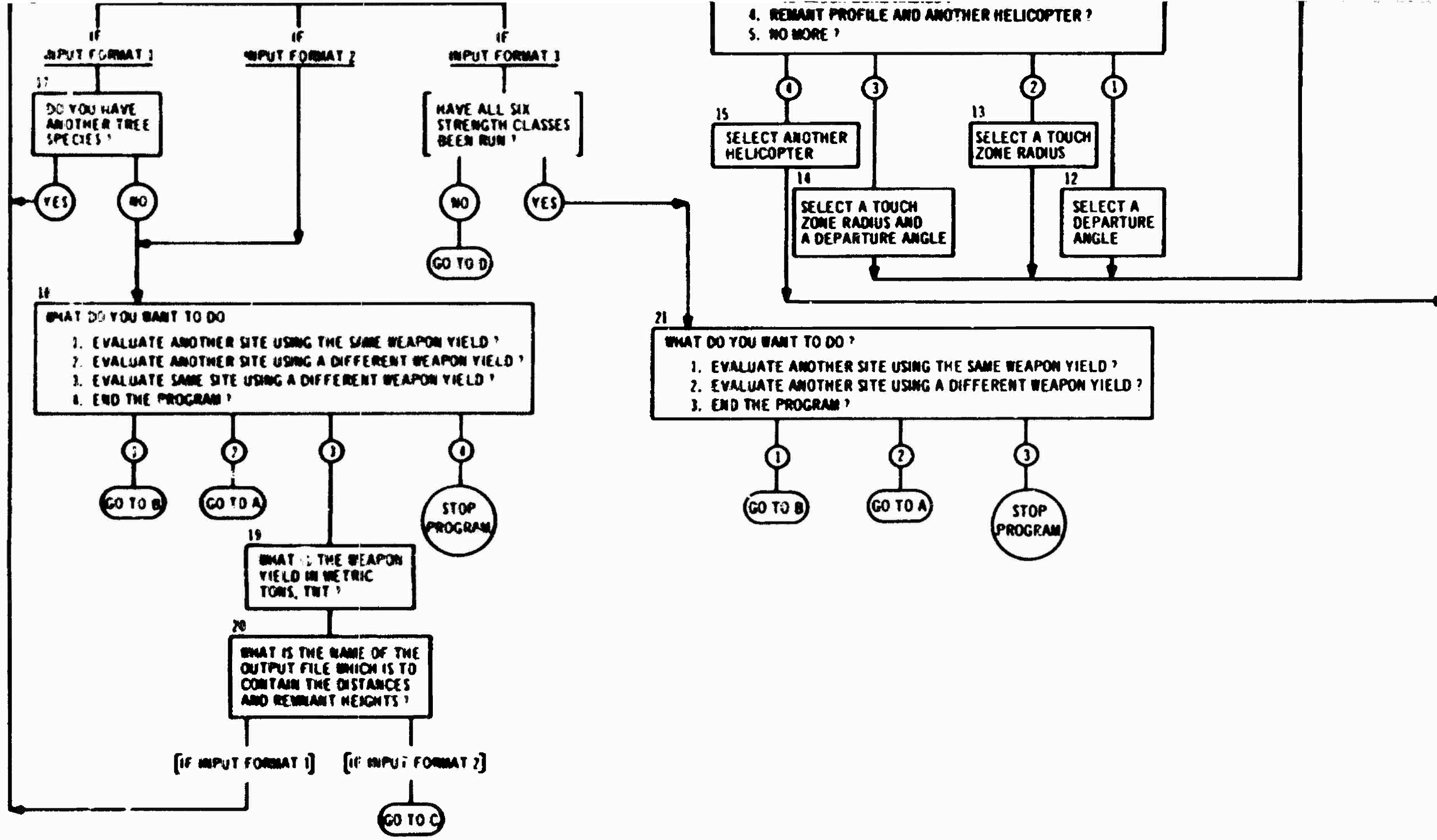


Figure 14. Flow diagram of program FTJPRH

3

```
* * * * * * * * * * * * * * * * * * * * * * * * *

IS YOUR KNOWLEDGE OF THIS PROGRAM AND ITS OPERATION
SUFFICIENT TO ELIMINATE TYPING THE GENERAL EXPLANATIONS
AND INSTRUCTIONS AND BEGIN IMMEDIATELY WITH THE INPUT
OF DATA ?  (TYPE YES OR NO)
=NO
                                               A

************************************************************


************************************************************
GIVEN A WEAPON YIELD (METRIC TONS, TNT) AND TREE
DESCRIPTIONS, THIS PROGRAM CALCULATES A VEGETATION
PROFILE (TREE REMNANT HEIGHT VERSUS DISTANCE FROM
GROUND ZERO) AND STORES IT IN A FILE FOR LATER USE.
AN OPTION IS PROVIDED TO GRAPHICALLY COMPARE THE
VEGETATION PROFILE WITH A PROFILE OF THE FLIGHT PATH
OF A HELICOPTER.  THE RELIABILITY OF THE OUTPUT IS
DEPENDENT ON THE DETAIL AND ACCURACY OF THE TREE
DESCRIPTIONS.

TREE DATA ARE INPUT USING ONE OF THREE FORMATS.  THE FIRST
IS FOR THE MOST SPECIFIC DATA AND THE SECOND IS FOR THE
MOST GENERAL DATA.  FORMAT 3 ALLOWS ENTRY OF TREE DATA ON
THE BASIS OF SIX WOOD STRENGTH CLASSES AND NINE STEM
DIAMETER CLASSES (54 COMBINATIONS).  USE OF FORMAT 3 IS
NECESSARY WHENEVER PREDICTIONS ARE NEEDED ON THE PROBABLE
NUMBER OF TREES REQUIRING REMOVAL AFTER A BOMB EXPLOSION.

**********
FORMAT 1: YOU ARE REQUESTED TO FURNISH DATA FOR ONE TREE
SPECIES.  UPON REQUEST, TYPE:

   COMMON NAME *

   TREE POSITIONS INDICATED BY ONE OF THE FOLLOWING:
     1. RADIAL DISTANCES FROM GROUND ZERO
     2. XY-COORDINATES (ALSO INCLUDES COORDINATES OF
        GROUND ZERO)
     3. AT 1-METER INTERVALS FROM GROUND ZERO
```

Figure 15. Sample run of computer program FTJPRH using vegetation input Format 1 presented in Figure 18 (sheet 1 of 6)

STEM DIAMETER

TREE HEIGHT

WOOD DENSITY, OR SPECIFIC GRAVITY AND MOISTURE CONTENT OF WOOD *

RUPTURE MODULUS *

YOUNG'S MODULUS PARALLEL TO STEM (MODULUS OF ELASTICITY IN COMPRESSION IS EQUAL TO MODULUS OF ELASTICITY + 10%) *

* SUGGESTED REFERENCE: TABLE 12, WOOD HANDBOOK NO. 72 USDA

NOTE: FOR CONVERTING UNITS IN TABLE 12 TO METRIC UNITS USE THE CONVERSION FACTOR 1 PSI = 68950 DYNES/SQ CM

****

FORMAT 2: YOU ARE REQUESTED TO LOOK THROUGH A LIST OF COMMON NAMES FOR TREE SPECIES AND CLASSIFY THE TREES IN THE PROPOSED LANDING SITE INTO SIX WOOD STRENGTH CLASSES. UPON REQUEST, TYPE:

MAXIMUM WOOD STRENGTH CLASS IN THE SITE

MAXIMUM STEM DIAMETER IN THAT STRENGTH CLASS

MAXIMUM TREE HEIGHT IN THAT STRENGTH CLASS

****

FORMAT 3: YOU ARE REQUESTED TO EXAMINE THE LIST OF COMMON NAMES FOR TREE SPECIES AND CLASSIFY THE TREES IN THE PROPOSED LANDING SITE INTO SIX STRENGTH CLASSES AND THEN INTO NINE STEM DIAMETER CLASSES. UPON REQUEST, TYPE:

MAXIMUM STEM DIAMETER IN EACH DIAMETER CLASS FOR EACH WOOD STRENGTH CLASS

MAXIMUM TREE HEIGHT IN EACH DIAMETER CLASS FOR EACH WOOD STRENGTH CLASS

Figure 15 (sheet 2 of 6)

```
**************************************************************


**************************************************************
YOU WILL NOW ENGAGE IN A CONVERSATION WITH THE COMPUTER
BY ANSWERING A SERIES OF QUESTIONS.  TWO INSTRUCTIONS TO
REMEMBER ARE:

 1. TO ANSWER YES OR NO QUESTIONS, TYPE YES OR NO.
 2. TO ANSWER QUESTIONS WITH MULTIPLE ANSWERS, TYPE
    EACH VALUE IN THE ORDER ASKED FOR AND SEPARATE
    THE VALUES WITH COMMAS.
**************************************************************


WHAT IS THE WEAPON YIELD IN METRIC TONS, TNT ?          B
   EXAMPLE: 10,000 LB GENERAL PURPOSE BOMB HAS A YIELD
            OF 3.6 METRIC TONS, TNT
=3.63

WHICH INPUT FORMAT DO YOU WANT TO USE ?                 C
 (TYPE 1, 2, OR 3)
=1

WHAT IS THE NAME OF THE OUTPUT FILE WHICH IS TO CONTAIN
THE DISTANCES AND REMNANT HEIGHTS ?
=RHF1
                                                        D

**************************************************************

I. ENTER THE COMMON NAME OF THIS TREE SPECIES. (NAME    E
   NOT TO EXCEED 39 CHARACTERS)
=ENGLEMANN SPRUCE

II. FOR THE TREE SPECIES, ENTER:
   1. TREE IDENTIFICATION NUMBER (NOT TO EXCEED 999)    F
   2. MODULUS OF RUPTURE (DYNES/CM SQ)
   3. YOUNG'S MODULUS (DYNES/CM SQ)

     EXAMPLE: 1,6.13E+8,1.06E+11
                                                        G
=1,3.103E+8,7.2747E+10

III. IF WOOD DENSITY IS AVAILABLE, ENTER:
       1,DENSITY VALUE,1
        EXAMPLE: 1,1.01,1
```

Figure 15 (sheet 3 of 6)

```
    IF NOT AVAILABLE, ENTER:
      2,SPECIFIC GRAVITY, MOISTURE CONTENT (PERCENT)        H
        EXAMPLE: 2,0.56,80

=1,0.58,1

IV. ENTER: TREE STEM DIAMETER (CM) AND TREE HEIGHT          I
    (M, TO NEAREST TENTH).
=10,5

DO YOU WANT TREE REMNANT HEIGHTS CALCULATED AT 1-METER      J
INTERVALS FROM GROUND ZERO ?
=YES

DO YOU WANT TO COMPARE THE TREE REMNANT HEIGHT PROFILE AND  K
THE LANDING ZONE GEOMETRY REQUIRED FOR A HELICOPTER ?
=YES


THE FOLLOWING HELICOPTER FILES ARE AVAILABLE:
    1. UH-1H, IROQUOIS
    2. UH-1B, IROQUOIS
    3. OH-6A, CAYUSE
    4. CH-47A, CHINOOK
    5. CH-47C, CHINOOK

SELECT A HELICOPTER AND TYPE ITS NUMBER.
=3                                                          L

SELECT  5.3 OR  8.0 METERS AS TOUCH ZONE RADIUS.
=8                                                          M

SELECT A DEPARTURE ANGLE WITHIN THE LIMITS OF  22. AND  90. DEGREES.
=40                                                         N

* * * * * * * * * * * * * * * * * * * * * * * * * *

    HELICOPTER                          OH-6A
    DEPARTURE ANGLE (DEG)                40.0
    RADIUS OF TOUCH ZONE (M)              8.0
    WEAPON YIELD (METRIC TONS, TNT)       3.6

TREE IDENTIFICATION NUMBER       1
COMMON SPECIES NAME: ENGLEMANN SPRUCE
MODULUS OF RUPTURE (DYNES/CM SQ)     0.31030000E 09
YOUNG'S MODULUS (DYNES/CM SQ)        0.72747000E 11
WOOD DENSITY (GRAMS/CM CUBED)                  0.58
```

Figure 15 (sheet 4 of 6)

MAXIMUM TREE DIAMETER (CM) 10.
MAXIMUM TREE HEIGHT (M) 5.

****

DISTANCE FROM GROUND ZERO (M)	TREE REMNANT HEIGHT (M)	HEIGHT OF GLIDE PATH (M)
3.00	0.25	0.24
4.00	0.29	0.24
5.00	0.32	0.24
6.00	0.35	0.24
7.00	0.36	0.24
8.00	0.38	0.24
9.00	0.40	1.08
10.00	0.43	1.92
11.00	0.46	2.76
12.00	0.49	3.60
13.00	0.53	4.44
14.00	0.57	5.27
15.00	0.62	6.11
16.00	0.67	6.95
17.00	0.73	7.79
18.00	0.79	8.63
19.00	0.85	9.47
20.00	0.93	10.31
21.00	1.02	11.15
22.00	1.11	11.99
23.00	1.22	12.83
24.00	1.34	13.67
25.00	1.48	14.50
26.00	1.71	15.34
27.00	2.09	16.18
28.00	2.75	17.02
29.00	3.73	17.86
30.00	4.94	18.70
31.00	5.00 *	19.54

* MAXIMUM TREE HEIGHT

Figure 15 (sheet 5 of 6)

```
* * * * * * * * * * * * * * * * * * * * * * * * *

DO YOU WANT TO COMPARE DATA FOR:
 1. REMNANT PROFILE AND ANOTHER DEPARTURE ANGLE (DA) ?
 2. REMNANT PROFILE AND ANOTHER TOUCH ZONE RADIUS (RTZ) ?
 3. REMNANT PROFILE AND ANOTHER DA AND RTZ ?
 4. REMNANT PROFILE AND ANOTHER HELICOPTER ?
 5. NO MORE ?

SELECT ONE AND TYPE ITS NUMBER.
=5

DO YOU HAVE ANOTHER TREE SPECIES ?          O
=NO

WHAT DO YOU WANT TO DO:                          P
 1. EVALUATE ANOTHER SITE USING THE SAME WEAPON YIELD ?
 2. EVALUATE ANOTHER SITE USING A DIFFERENT WEAPON YIELD ?
 3. EVALUATE SAME SITE USING A DIFFERENT WEAPON YIELD ?
 4. END THE PROGRAM ?

SELECT ONE AND TYPE ITS NUMBER.
=4


* * * * * * * * * * * * * * * * * * * * * * * * *
```

Figure 15 (sheet 6 of 6)

```
* * * * * * * * * * * * * * * * * * * * * * * * *

IS YOUR KNOWLEDGE OF THIS PROGRAM AND ITS OPERATION
SUFFICIENT TO ELIMINATE TYPING THE GENERAL EXPLANATIONS
AND INSTRUCTIONS AND BEGIN IMMEDIATELY WITH THE INPUT
OF DATA ?  (TYPE YES OR NO)
=YES                                                    A


WHAT IS THE WEAPON YIELD IN METRIC TONS, TNT ?
   EXAMPLE: 10,000 LB GENERAL PURPOSE BOMB HAS A YIELD
            OF 3.6 METRIC TONS, TNT
=3.63                                                   B

WHICH INPUT FORMAT DO YOU WANT TO USE ?
 (TYPE 1, 2, OR 3)                                      C
=2

WHAT IS THE NAME OF THE OUTPUT FILE WHICH IS TO CONTAIN
THE DISTANCES AND REMNANT HEIGHTS ?
=RHF2                                                   D

**************************************************************
IF YOU DO NOT HAVE THE WOOD STRENGTH CLASS OF THE TREE
SPECIES IN YOUR SITE, EXAMINE THE LIST OF COMMON NAMES
OF TREE SPECIES THAT HAVE BEEN CLASSIFIED BY WOOD
STRENGTH AND COMPILED INTO TWO TABLES IN THE INSTRUCTION
REPORT FOR THIS COMPUTER PROGRAM (TABLES 6 AND 7).
SELECT THE STRENGTH CLASSES HAVING TREES MOST LIKE THOSE
IN THE LANDING SITE IF THE EXACT SPECIES IS NOT INCLUDED
IN THE LIST.
**************************************************************
```

Figure 16. Sample run of computer program FTJPRH using vegetation input Format 2 presented in Figure 19 (sheet 1 of 6)

```
TYPE VALUES FOR:
 1. MAXIMUM WOOD STRENGTH CLASS IN THE SITE
 2. MAXIMUM STEM DIAMETER (CM) IN THAT CLASS
 3. MAXIMUM TREE HEIGHT (M, TO NEAREST TENTH) IN
    THAT CLASS                                       E
=4,12,7.0

DO YOU WANT TO COMPARE THE TREE REMNANT HEIGHT PROFILE AND
THE LANDING ZONE GEOMETRY REQUIRED FOR A HELICOPTER ?      F
=YES


THE FOLLOWING HELICOPTER FILES ARE AVAILABLE:
    1. UH-1H, IROQUOIS
    2. UH-1B, IROQUOIS
    3. OH-6A, CAYUSE
    4. CH-47A, CHINOOK
    5. CH-47C, CHINOOK

SELECT A HELICOPTER AND TYPE ITS NUMBER.
=4

SELECT 21.0 OR 26.0 METERS AS TOUCH ZONE RADIUS.
=21

* * * * * * * * * * * * * * * * * * * * * * * * * *
```

Figure 16 (sheet 2 of 6)

HELICOPTER	CH-47A
DEPARTURE ANGLE (DEG)	90.0
RADIUS OF TOUCH ZONE (M)	21.0
WEAPON YIELD (METRIC TONS, TNT)	3.6
WOOD STRENGTH CLASS	4
MAXIMUM TREE DIAMETER (CM)	12.
MAXIMUM TREE HEIGHT (M)	7.

****

DISTANCE FROM GROUND ZERO (M)	TREE REMNANT HEIGHT (M)	HEIGHT OF GLIDE PATH (M)
3.00	0.43	0.50
4.00	0.56	0.50
5.00	0.64	0.50
6.00	0.69	0.50
7.00	0.74	0.50
8.00	0.78	0.50
9.00	0.83	0.50
10.00	0.89	0.50
11.00	0.96	0.50
12.00	1.05	0.50
13.00	1.15	0.50
14.00	1.27	0.50
15.00	1.41	0.50
16.00	1.63	0.50
17.00	2.06	0.50
18.00	2.93	0.50
19.00	4.35	0.50
20.00	5.90	0.50
21.00	6.84	0.50

RADIUS OF TOUCH ZONE

* *

Figure 16 (sheet 3 of 6)

```
DO YOU WANT TO COMPARE DATA FOR:
 1. REMNANT PROFILE AND ANOTHER DEPARTURE ANGLE (DA) ?
 2. REMNANT PROFILE AND ANOTHER TOUCH ZONE RADIUS (RTZ) ?
 3. REMNANT PROFILE AND ANOTHER DA AND RTZ ?
 4. REMNANT PROFILE AND ANOTHER HELICOPTER ?
 5. NO MORE ?

SELECT ONE AND TYPE ITS NUMBER.
=5

WHAT DO YOU WANT TO DO:
 1. EVALUATE ANOTHER SITE USING THE SAME WEAPON YIELD ?
 2. EVALUATE ANOTHER SITE USING A DIFFERENT WEAPON YIELD ?
 3. EVALUATE SAME SITE USING A DIFFERENT WEAPON YIELD ?
 4. END THE PROGRAM ?

SELECT ONE AND TYPE ITS NUMBER.
=3

WHAT IS THE WEAPON YIELD IN METRIC TONS, TNT ?
=6.63

WHAT IS THE NAME OF THE OUTPUT FILE WHICH IS TO CONTAIN
THE DISTANCES AND REMNANT HEIGHTS ?
=RHF3

DO YOU WANT TO COMPARE THE TREE REMNANT HEIGHT PROFILE AND
THE LANDING ZONE GEOMETRY REQUIRED FOR A HELICOPTER ?
=YES


THE FOLLOWING HELICOPTER FILES ARE AVAILABLE:
    1. UH-1H, IROQUOIS
    2. UH-1B, IROQUOIS
    3. OH-6A, CAYUSE
    4. CH-47A, CHINOOK
    5. CH-47C, CHINOOK

SELECT A HELICOPTER AND TYPE ITS NUMBER.
=4
```

G

H

Figure 16 (sheet 4 of 6)

SELECT 21•0 OR 26•0 METERS AS TOUCH ZONE RADIUS•
=21

* *

HELICOPTER	CH-47A
DEPARTURE ANGLE (DEG)	90•0
RADIUS OF TOUCH ZONE (M)	21•0
WEAPON YIELD (METRIC TONS, TNT)	6•6
WOOD STRENGTH CLASS	4
MAXIMUM TREE DIAMETER (CM)	12•
MAXIMUM TREE HEIGHT (M)	7•

****

DISTANCE FROM GROUND ZERO (M)	TREE REMNANT HEIGHT (M)	HEIGHT OF GLIDE PATH (M)
3•00	0•33	0•50
4•00	0•42	0•50
5•00	0•50	0•50
6•00	0•56	0•50
7•00	0•60	0•50
8•00	0•64	0•50
9•00	0•67	0•50
10•00	0•70	0•50
11•00	0•74	0•50
12•00	0•77	0•50
13•00	0•82	0•50
14•00	0•87	0•50
15•00	0•93	0•50
16•00	1•00	0•50
17•00	1•08	0•50
18•00	1•17	0•50
19•00	1•27	0•50
20•00	1•39	0•50
21•00	1•55	0•50

RADIUS OF TOUCH ZONE

Figure 16 (sheet 5 of 6)

```
* * * * * * * * * * * * * * * * * * * * * * * * *

DO YOU WANT TO COMPARE DATA FOR:
 1. REMNANT PROFILE AND ANOTHER DEPARTURE ANGLE (DA) ?
 2. REMNANT PROFILE AND ANOTHER TOUCH ZONE RADIUS (RTZ) ?
 3. REMNANT PROFILE AND ANOTHER DA AND RTZ ?
 4. REMNANT PROFILE AND ANOTHER HELICOPTER ?
 5. NO MORE ?

SELECT ONE AND TYPE ITS NUMBER.
=5

WHAT DO YOU WANT TO DO:
 1. EVALUATE ANOTHER SITE USING THE SAME WEAPON YIELD ?
 2. EVALUATE ANOTHER SITE USING A DIFFERENT WEAPON YIELD ?
 3. EVALUATE SAME SITE USING A DIFFERENT WEAPON YIELD ?
 4. END THE PROGRAM ?

SELECT ONE AND TYPE ITS NUMBER.
=4


* * * * * * * * * * * * * * * * * * * * * * * * *
```

Figure 16 (sheet 6 of 6)

```
* * * * * * * * * * * * * * * * * * * * * * * * *

IS YOUR KNOWLEDGE OF THIS PROGRAM AND ITS OPERATION
SUFFICIENT TO ELIMINATE TYPING THE GENERAL EXPLANATIONS
AND INSTRUCTIONS AND BEGIN IMMEDIATELY WITH THE INPUT
OF DATA ?  (TYPE YES OR NO)
=YES                                                    (A)


WHAT IS THE WEAPON YIELD IN METRIC TONS, TNT ?
   EXAMPLE: 10,000 LB GENERAL PURPOSE BOMB HAS A YIELD
            OF 3.6 METRIC TONS, TNT
=6.63                                                   (B)

WHICH INPUT FORMAT DO YOU WANT TO USE ?
 (TYPE 1, 2, OR 3)                                      (C)
=3

WHAT IS THE NAME OF THE OUTPUT FILE WHICH IS TO CONTAIN
THE DISTANCES AND REMNANT HEIGHTS ?
=RHF3                                                   (D)

**************************************************************
IF YOU DO NOT HAVE THE WOOD STRENGTH CLASS OF THE TREE
SPECIES IN YOUR SITE, EXAMINE THE LIST OF COMMON NAMES
OF TREE SPECIES THAT HAVE BEEN CLASSIFIED BY WOOD
STRENGTH AND COMPILED INTO TWO TABLES IN THE INSTRUCTION
REPORT FOR THIS COMPUTER PROGRAM (TABLES 6 AND 7).
SELECT THE STRENGTH CLASSES HAVING TREES MOST LIKE THOSE
IN THE LANDING SITE IF THE EXACT SPECIES IS NOT INCLUDED
IN THE LIST.
**************************************************************


EACH STRENGTH CLASS WILL BE DESIGNATED AND ALL NINE STEM
DIAMETER CLASSES FOR EACH STRENGTH CLASS.  WHEN THE STEM
DIAMETER CLASSES ARE DESIGNATED, TYPE A ZERO (0) IF STEMS
DO NOT OCCUR IN A DIAMETER CLASS, OR ENTER THE MAXIMUM
STEM DIAMETER (CM) AND MAXIMUM TREE HEIGHT (M, TO NEAREST
TENTH) OCCURRING IN THE DIAMETER CLASS.
                                                        (E)


ARE THERE ANY TREES IN STRENGTH CLASS  1 ?
=YES
```

Figure 17. Sample run of computer program FTJPRH using vegetation input Format 3 presented in Figure 20 (sheet 1 of 6)

```
DIAMETER CLASS  1
=0,0

DIAMETER CLASS  2
=8,2

DIAMETER CLASS  3
=10,2

DIAMETER CLASS  4
=0,0

DIAMETER CLASS  5
=25,3

DIAMETER CLASS  6
=0,0

DIAMETER CLASS  7
=0,0

DIAMETER CLASS  8
=0,0

DIAMETER CLASS  9
=0,0


DO YOU WANT TO COMPARE THE TREE REMNANT HEIGHT PROFILE
FOR DIAMETER CLASS  5, STRENGTH CLASS  1 AND THE          F
LANDING ZONE GEOMETRY REQUIRED FOR A HELICOPTER ?
=NO


ARE THERE ANY TREES IN STRENGTH CLASS  2 ?
=NO                                                        G


ARE THERE ANY TREES IN STRENGTH CLASS  3 ?
=NO


ARE THERE ANY TREES IN STRENGTH CLASS  4 ?
=YES
```

Figure 17 (sheet 2 of 6)

```
DIAMETER CLASS  1
=0,0

DIAMETER CLASS  2
=9,4

DIAMETER CLASS  3
=12,3

DIAMETER CLASS  4
=18,3

DIAMETER CLASS  5
=0,0

DIAMETER CLASS  6
=0,0

DIAMETER CLASS  7
=0,0

DIAMETER CLASS  8
=0,0

DIAMETER CLASS  9
=0,0


DO YOU WANT TO COMPARE THE TREE REMNANT HEIGHT PROFILE
FOR DIAMETER CLASS  4, STRENGTH CLASS  4 AND THE
LANDING ZONE GEOMETRY REQUIRED FOR A HELICOPTER ?
=NO


ARE THERE ANY TREES IN STRENGTH CLASS  5 ?
=YES

DIAMETER CLASS  1
=0,0

DIAMETER CLASS  2
=0,0

DIAMETER CLASS  3
=0,0
```

Figure 17 (sheet 3 of 6)

DIAMETER CLASS 4
=0,0

DIAMETER CLASS 5
=33,5

DIAMETER CLASS 6
=60,6

DIAMETER CLASS 7
=0,0

DIAMETER CLASS 8
=0,0

DIAMETER CLASS 9
=0,0

DO YOU WANT TO COMPARE THE TREE REMNANT HEIGHT PROFILE
FOR DIAMETER CLASS 6, STRENGTH CLASS 5 AND THE
LANDING ZONE GEOMETRY REQUIRED FOR A HELICOPTER ?
=YES

THE FOLLOWING HELICOPTER FILES ARE AVAILABLE:
1. UH-1H, IROQUOIS
2. UH-1B, IROQUOIS
3. OH-6A, CAYUSE
4. CH-47A, CHINOOK
5. CH-47C, CHINOOK

SELECT A HELICOPTER AND TYPE ITS NUMBER.
=2

SELECT 10.0 OR 15.0 METERS AS TOUCH ZONE RADIUS.
=10

SELECT A DEPARTURE ANGLE WITHIN THE LIMITS OF 22. AND 75. DEGREES.
=35

Figure 17 (sheet 4 of 6)

* *

HELICOPTER	UH-1B
DEPARTURE ANGLE (DEG)	35.0
RADIUS OF TOUCH ZONE (M)	10.0
WEAPON YIELD (METRIC TONS, TNT)	6.6
WOOD STRENGTH CLASS	5
MAXIMUM TREE DIAMETER (CM)	60.
MAXIMUM TREE HEIGHT (M)	6.

****

DISTANCE FROM GROUND ZERO (M)	TREE REMNANT HEIGHT (M)	HEIGHT OF GLIDE PATH (M)
3.00	1.45	0.30
4.00	1.81	0.30
5.00	2.19	0.30
6.00	2.52	0.30
7.00	2.79	0.30
8.00	3.03	0.30
9.00	3.32	0.30
10.00	3.72	0.30
11.00	4.35	1.00
12.00	5.39	1.70
13.00	6.00 *	2.40
14.00	6.00	3.10
15.00	6.00	3.80
16.00	6.00	4.50
17.00	6.00	5.20
18.00	6.00	5.90
19.00	6.00	6.60

* MAXIMUM TREE HEIGHT

* *

Figure 17 (sheet 5 of 6)

```
DO YOU WANT TO COMPARE DATA FOR:                    (H)
 1. REMNANT PROFILE AND ANOTHER DEPARTURE ANGLE (DA) ?
 2. REMNANT PROFILE AND ANOTHER TOUCH ZONE RADIUS (RTZ) ?
 3. REMNANT PROFILE AND ANOTHER DA AND RTZ ?
 4. REMNANT PROFILE AND ANOTHER HELICOPTER ?
 5. NO MORE ?

SELECT ONE AND TYPE ITS NUMBER.
=5


ARE THERE ANY TREES IN STRENGTH CLASS  6 ?
=NO
                                                     (I)
WHAT DO YOU WANT TO DO:
 1. EVALUATE ANOTHER SITE USING THE SAME WEAPON YIELD ?
 2. EVALUATE ANOTHER SITE USING A DIFFERENT WEAPON YIELD ?
 3. END THE PROGRAM ?

SELECT ONE AND TYPE ITS NUMBER.
=3


* * * * * * * * * * * * * * * * * * * * * * * * *
```

Figure 17 (sheet 6 of 6)

Vegetation Input Data Format 1

Site Sample 1

Weapon yield 3.63 Output file name RHF1

Item	Value
1. Common name (not to exceed 30 characters)	Englemann Spruce
2. Tree identification number (1-999)	1
3. Modulus of rupture, dynes/cm^2*	3.103E+8
4. Young's modulus, dynes/cm^2*	7.2747E+10
5. Wood density (green), g/cm^3	0.58
OR	
Specific gravity and	
Moisture content, %	
6. Stem diameter, cm, measured at height of 1 m above stem base	10
7. Maximum tree height, m to nearest tenth	5
8. Tree positions; select one method from the following:	
a. Calculate at 1-m intervals from GZ	YES X NO ____
b. Several locations of this tree at discrete distances from GZ, m; enter distances in ascending order (maximum of 115 positions)	No. locations: ____ Distances:
c. Locations of this tree defined by XY-coordinates; enter coordinates of GZ first, then follow with X and Y for each tree position (maximum of 115 positions)	No. locations: ____ Coordinates:

* These values are quite large, and it is much easier to enter the value as a number with an exponent (as a power of 10). In computer language, E represents the term, power of 10, e.g.

Modulus of rupture = 524400000. = 5.244E+8

Figure 18. Completed form for Format 1 data (these data used in sample run in Figure 15)

Vegetation Input Data Format 2 *

Site Sample 2

Weapon yield 3.63 Output file name RHF2

Item	Value
1. Maximum wood strength class occurring in the site	4
2. Maximum stem diameter, cm, in the maximum wood strength class	12
3. Maximum tree height, m to nearest tenth, in the maximum wood strength class	7

* This format uses maximum conditions present in a site and evaluates the site as a prospective landing zone by comparing the vertical clearances required by the landing of a helicopter to the vegetation profile of the clearing that results where these extreme conditions exist.

Figure 19. Completed form for Format 2 data (these data used in sample run in Figure 16)

Vegetation Input Data Format 3

Site Sample 3

Weapon yield 6.63 Output file name RHF3

Maximum Stem Diameter and Tree Height

Diameter Class		Wood Strength Class 1	2	3	4	5	6
1	Diam, cm						
	Height, m						
2	Diam, cm	8			9		
	Height, m	2.0			4.0		
3	Diam, cm	10			12		
	Height, m	2.0			3.0		
4	Diam, cm				18		
	Height, m				3.0		
5	Diam, cm	25				33	
	Height, m	3.0				5.0	
6	Diam, cm					60	
	Height, m					6.0	
7	Diam, cm						
	Height, m						
8	Diam, cm						
	Height, m						
9	Diam, cm						
	Height, m						

DIAMETER CLASS RANGES

Diameter Class	Strength Class 1	2	3	4	5	6
1	0-7	0-7	0-7	0-7	0-7	0-7
2	7-9	7-10	7-10	7-10	7-10	7-10
3	9-14	10-14	10-15	10-15	10-15	10-15
4	14-18	14-19	15-20	15-20	15-20	15-20
5	18-23	19-24	20-24	20-25	20-25	20-25
6	23-34	24-36	24-37	25-38	25-38	25-38
7	34-46	36-48	37-49	38-50	38-50	38-51
8	46-68	48-72	49-73	50-75	50-75	51-76
9	68-85	7[illegible]-91	73-91	75-94	75-94	76-95

Figure 20. Completed form for Format 3 data (these data used in sample run in Figure 17)

Input Data Summary for Program FTJPHL

Sample No.	______
Helicopter	______
Touch zone radius, m	______
Departure angle, deg	______
Landing zone design	______
Remnant height file name	______
Weapon yield, metric tons TNT	______
Number of trees/100 m^2	______
Number of species	______

Common names of species:

(1) ______	(11) ______
(2) ______	(12) ______
(3) ______	(13) ______
(4) ______	(14) ______
(5) ______	(15) ______
(6) ______	(16) ______
(7) ______	(17) ______
(8) ______	(18) ______
(9) ______	(19) ______
(10) ______	(20) ______

Figure 21. Daca input form for program FTJPHL

```
* * * * * * * * * * * * * * * * * * * * * * * * *

          DATA FOR THE  UH-1B  IROQUOIS
            DEPARTURE ANGLE  (DEG)   45.
            TOUCH ZONE RADIUS  (M)   10.
            RECTANGULAR LANDING ZONE
       WEAPON YIELD  (METRIC TONS, TNT)  6.6

            ************************
                VEGETATION DATA
            ************************

       STRENGTH CLASS                       5
       DIAMETER CLASS (CM)                  8
       MAXIMUM TREE HEIGHT (M)             19.
       NUMBER OF TREES PER 100 SQ. M        2.15

    NUMBER OF TREES TO BE CLEARED               8

      DIAMETER RANGE OF  50 -  75 CM
      INCLUDING THESE SPECIES:
        DOGWOOD
        POST OAK
```

Figure 22. Example of output of program FTJPHL

Input Data Summary for Program FTJPHL

Sample No.	A
Helicopter	UH-1B
Touch zone radius, m	10
Departure angle, deg	45
Landing zone design	RECTANGULAR
Remnant height file name	RHF6
Weapon yield, metric tons TNT	6.63
Number of trees/100 m^2	2.15
Number of species	2

Common names of species:

(1)	DOGWOOD	(11)	
(2)	POST OAK	(12)	
(3)		(13)	
(4)		(14)	
(5)		(15)	
(6)		(16)	
(7)		(17)	
(8)		(18)	
(9)		(19)	
(10)		(20)	

Figure 23. Example of completed data input form for program FTJPHL

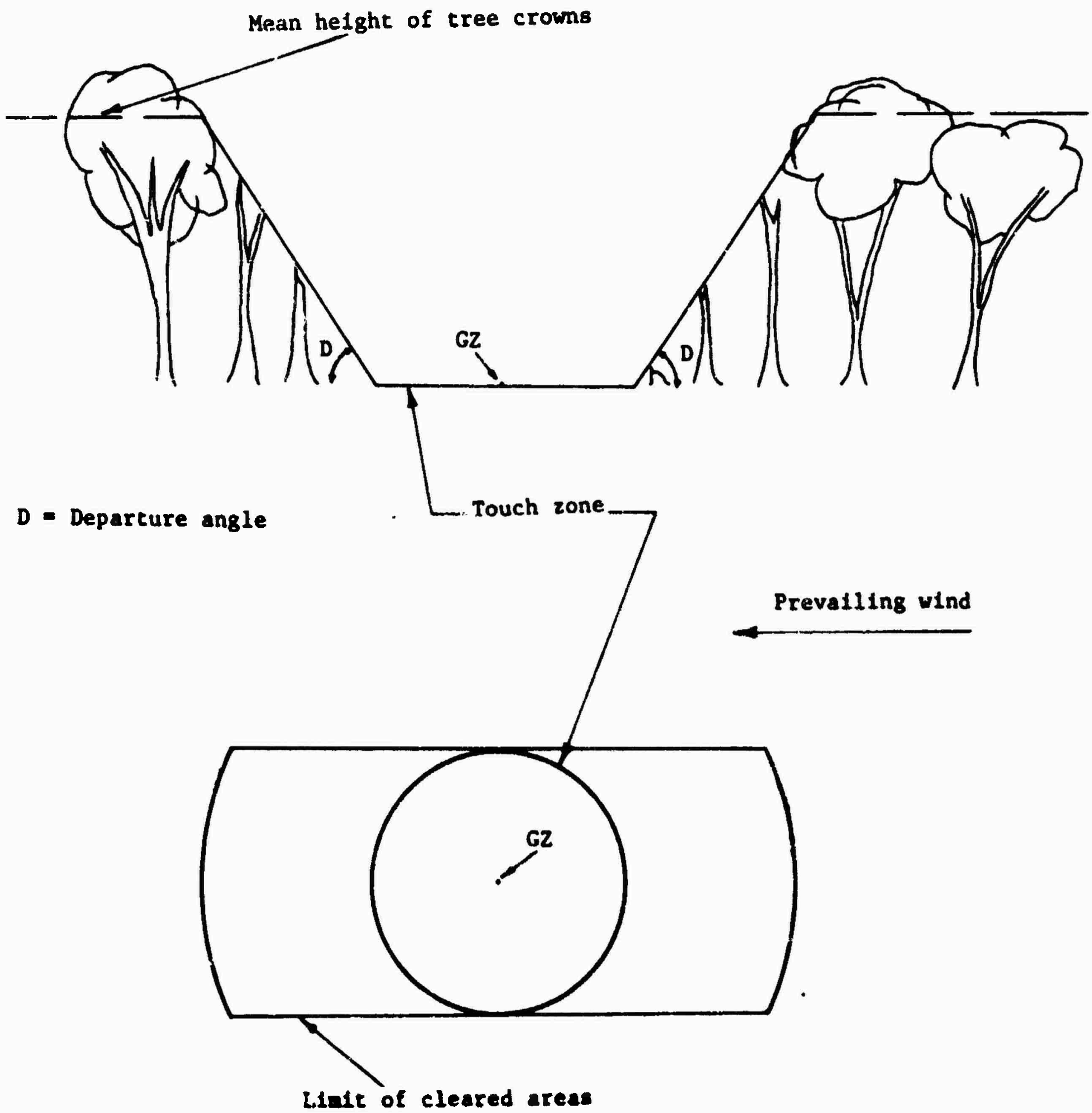


Figure 24. Schematic diagram of rectangular design for helicopter landing zone

Input Data Summary for Program FTJPHL

Diameter class ________ Strength class ________

Number of trees/100 m^2 ________

Number of species ________

Common names of species:

(1) ________ (4) ________

(2) ________ (5) ________

(3) ________ (6) ________

Diameter class ________ Strength class ________

Number of trees/100 m^2 ________

Number of species ________

Common names of species:

(1) ________ (4) ________

(2) ________ (5) ________

(3) ________ (6) ________

Diameter class ________ Strength class ________

Number of trees/100 m^2 ________

Number of species ________

Common names of species:

(1) ________ (4) ________

(2) ________ (5) ________

(3) ________ (6) ________

Figure 25. Supplementary data input form for program FTJPHL

```
THE FOLLOWING HELICOPTER FILES ARE AVAILABLE:
     1. UH-1H, IROQUOIS
     2. UH-1B, IROQUOIS
     3. OH-6A, CAYUSE
     4. CH-47A, CHINOOK
     5. CH-47C, CHINOOK

SELECT A HELICOPTER AND TYPE ITS NUMBER.
=2                                                          A

SELECT   10.00 OR   15.00 METERS AS TOUCH ZONE RADIUS.
=10                                                         B

SELECT A DEPARTURE ANGLE WITHIN THE RANGE OF  22. AND  75. DEG.
=45                                                         C

WHICH LANDING ZONE DESIGN DO YOU WANT ?  (TYPE 1 IF CIRCULAR;
TYPE 2 IF RECTANGULAR.)
=2                                                          D

WHAT IS THE NAME OF THE INPUT FILE THAT CONTAINS THE
DISTANCES AND REMNANT HEIGHTS ?
=RHF6                                                       E

WHAT IS THE WEAPON YIELD  (METRIC TONS, TNT) ?
=6.63                                                       F

HOW MANY TREES PER 100 SQ M ARE THERE IN STRENGTH
CLASS  5 DIAMETER CLASS  8 ?
=2.15                                                       G

HOW MANY SPECIES ARE INCLUDED IN STRENGTH CLASS  5
DIAMETER CLASS  8 (NOT TO EXCEED 20) ?
=2                                                          H

WHAT IS THE COMMON NAME FOR SPECIES NO.   1
=DOGWOOD                                                    I

WHAT IS THE COMMON NAME FOR SPECIES NO.   2
=POST OAK
```

Figure 26. Example of analytical procedure (sheet 1 of 5)

```
        DATA FOR THE  UH-1B  IROQUOIS
          DEPARTURE ANGLE  (DEG)   45.
          TOUCH ZONE RADIUS  (M)   10.
          RECTANGULAR LANDING ZONE
     WEAPON YIELD  (METRIC TONS, TNT)  6.6

           ************************
              VEGETATION DATA
           ************************

     STRENGTH CLASS                    5
     DIAMETER CLASS (CM)               8
     MAXIMUM TREE HEIGHT (M)          19.
     NUMBER OF TREES PER 100 SQ. M     2.15

  NUMBER OF TREES TO BE CLEARED          8

    DIAMETER RANGE OF  50 -  75 CM
    INCLUDING THESE SPECIES:
      DOGWOOD
      POST OAK


* * * * * * * * * * * * * * * * * * * * * * * * *

DO YOU WANT TO RUN ANOTHER REMNANT HEIGHT FILE ?
=NO                                                  J

DO YOU WANT TO:
  1. RUN ANOTHER DEPARTURE ANGLE, SAME TOUCH ZONE RADIUS ?
  2. RUN ANOTHER DEPARTURE ANGLE AND ANOTHER RADIUS ?
  3. RUN THE SAME ANGLE AND ANOTHER RADIUS ?            K
  4. RUN ANOTHER HELICOPTER ?
  5. END THE PROGRAM ?

MAKE A SELECTION AND TYPE ITS NUMBER.
=1
                                                     L
TYPE THE ANGLE (DEG).
=35
```

Figure 26 (sheet 2 of 5)

```
WHICH LANDING ZONE DESIGN DO YOU WANT ?  (TYPE 1 IF CIRCULAR;
TYPE 2 IF RECTANGULAR.)
=2                                                        M

* * * * * * * * * * * * * * * * * * * * * * * * *

          DATA FOR THE  UH-1B  IROQUOIS
            DEPARTURE ANGLE  (DEG)   35.
            TOUCH ZONE RADIUS  (M)   10.
            RECTANGULAR LANDING ZONE
       WEAPON YIELD  (METRIC TONS, TNT)  6.6

             ************************
                 VEGETATION DATA
             ************************

       STRENGTH CLASS                      5
       DIAMETER CLASS (CM)                 8
       MAXIMUM TREE HEIGHT (M)            19.
       NUMBER OF TREES PER 100 SQ. M       2.15

    NUMBER OF TREES TO BE CLEARED             9

      DIAMETER RANGE OF  50 -  75 CM
      INCLUDING THESE SPECIES:
        DOGWOOD
        POST OAK


* * * * * * * * * * * * * * * * * * * * * * * * *


DO YOU WANT TO RUN ANOTHER REMNANT HEIGHT FILE ?
=NO


DO YOU WANT TO:
  1. RUN ANOTHER DEPARTURE ANGLE, SAME TOUCH ZONE RADIUS ?
  2. RUN ANOTHER DEPARTURE ANGLE AND ANOTHER RADIUS ?
  3. RUN THE SAME ANGLE AND ANOTHER RADIUS ?
  4. RUN ANOTHER HELICOPTER ?
  5. END THE PROGRAM ?

MAKE A SELECTION AND TYPE ITS NUMBER.
=4
```

Figure 26 (sheet 3 of 5)

```
SELECT ANOTHER HELICOPTER FROM THE LIST AND TYPE ITS
NUMBER.
=5                                                    N

SELECT   26.00 OR   17.25 METERS AS TOUCH ZONE RADIUS.
=26

SELECT A DEPARTURE ANGLE WITHIN THE RANGE OF  22. AND  66. DEG.
=45                                                        O

WHICH LANDING ZONE DESIGN DO YOU WANT ?  (TYPE 1 IF CIRCULAR;
TYPE 2 IF RECTANGULAR.)
=2


* * * * * * * * * * * * * * * * * * * * * * * * *

          DATA FOR THE  CH-47C  CHINOOK
            DEPARTURE ANGLE  (DEG)   45.
            TOUCH ZONE RADIUS  (M)   26.
            RECTANGULAR LANDING ZONE
       WEAPON YIELD  (METRIC TONS, TNT)  6.6

             ************************
                VEGETATION DATA
             ************************

       STRENGTH CLASS                     5
       DIAMETER CLASS (CM)                8
       MAXIMUM TREE HEIGHT (M)           19.
       NUMBER OF TREES PER 100 SQ. M      2.15

    NUMBER OF TREES TO BE CLEARED           48

      DIAMETER RANGE OF  50 -  75 CM
      INCLUDING THESE SPECIES:
        DOGWOOD
        POST OAK


* * * * * * * * * * * * * * * * * * * * * * * * *
```

Figure 26 (sheet 4 of 5)

```
DO YOU WANT TO RUN ANOTHER REMNANT HEIGHT FILE ?
=NO                                                         (P)

DO YOU WANT TO:
  1. RUN ANOTHER DEPARTURE ANGLE, SAME TOUCH ZONE RADIUS ?
  2. RUN ANOTHER DEPARTURE ANGLE AND ANOTHER RADIUS ?
  3. RUN THE SAME ANGLE AND ANOTHER RADIUS ?
  4. RUN ANOTHER HELICOPTER ?
  5. END THE PROGRAM ?

MAKE A SELECTION AND TYPE ITS NUMBER.
=5                                                          (Q)



* * * * * * * * * * * * * * * * * * * * * * * * *
```

Figure 26 (sheet 5 of 5)

Input Data Summary for Program FTJPHL

Sample No.	A
Helicopter	UH-1B
Touch zone radius, m	10
Departure angle, deg	45
Landing zone design	RECTANGULAR
Remnant height file name	RHF6
Weapon yield, metric tons TNT	6.63
Number of trees/100 m^2	2.15
Number of species	2

Common names of species:

(1)	DOGWOOD	(11)	
(2)	POST OAK	(12)	
(3)		(13)	
(4)		(14)	
(5)		(15)	
(6)		(16)	
(7)		(17)	
(8)		(18)	
(9)		(19)	
(10)		(20)	

Figure 27. Three completed data input forms used for example of analytical procedure (sheet 1 of 3)

Input Data Summary for Program FTJPHL

Sample No.	A (CONTINUED)
Helicopter	
Touch zone radius, m	
Departure angle, deg	35
Landing zone design	RECTANGULAR
Remnant height file name	
Weapon yield, metric tons TNT	
Number of trees/100 m^2	
Number of species	

Common names of species:

(1)		(11)	
(2)		(12)	
(3)		(13)	
(4)		(14)	
(5)		(15)	
(6)		(16)	
(7)		(17)	
(8)		(18)	
(9)		(19)	
(10)		(20)	

Figure 27 (sheet 2 of 3)

Input Data Summary for Program FTJPHL

Sample No.	A (CONTINUED)
Helicopter	CH-47C
Touch zone radius, m	26
Departure angle, deg	45
Landing zone design	RECTANGULAR
Remnant height file name	
Weapon yield, metric tons TNT	
Number of trees/100 m^2	
Number of species	

Common names of species:

(1)		(11)	
(2)		(12)	
(3)		(13)	
(4)		(14)	
(5)		(15)	
(6)		(16)	
(7)		(17)	
(8)		(18)	
(9)		(19)	
(10)		(20)	

Figure 27 (sheet 3 of 3)

Table 1

Data File of Descriptors

for UH-1H Iroquois*

THE HELICOPTER DESCRIBED BY THESE DATA IS THE
UH-1H IROQUOIS

0	LIFT-OFF CODE (0 = NOT VERTICAL, 1 = VERTICAL)
0.39	GROUND CLEARANCE OF HULL (M)
66.0	APPROACH ANGLE (DEG)
22.0	DEPARTURE ANGLE - MINIMUM VALUE (DEG)
66.0	DEPARTURE ANGLE - MEDIAN VALUE (DEG)
90.0	DEPARTURE ANGLE - MAXIMUM VALUE (DEG)
10.5	RADIUS OF TOUCH ZONE - MINIMUM (M)
15.0	RADIUS OF TOUCH ZONE - MAXIMUM (M)
15.0	MAXIMUM SAFE GROUND SLOPE FOR A FTZ (PERCENT)
23.0	MAXIMUM SAFE GROUND SLOPE FOR A STZ (PERCENT)
46.0	MAXIMUM SAFE GROUND SLOPE FOR A NTZ (PERCENT)
18.0	CONE INDEX FOR A FTZ, MAXIMUM LOAD (PSI)
2.85	MAXIMUM WIDTH OF CROSS-SECTION OF HULL (M)
13.66	LENGTH OF HULL (M)
14.71	DIAMETER OF ROTOR (M)
2.37	GROUND CLEARANCE OF ROTOR BLADES - STATIC (M)
0.0	GROUND CLEARANCE OF ROTOR BLADES - IDLING (M)
7800.	WEIGHT - EMPTY (LBS)
9500.	WEIGHT - MAXIMUM LOAD (LBS)

* See References 3 and 4.

Table 2

Data File of Descriptors

for UH-1B Iroquois*

THE HELICOPTER DESCRIBED BY THESE DATA IS THE
UH-1B IROQUOIS

0	LIFT-OFF CODE (0 = NOT VERTICAL, 1 = VERTICAL)
0.3	GROUND CLEARANCE OF HULL (M)
66.0	APPROACH ANGLE (DEG)
22.0	DEPARTURE ANGLE - MINIMUM VALUE (DEG)
50.0	DEPARTURE ANGLE - MEDIAN VALUE (DEG)
75.0	DEPARTURE ANGLE - MAXIMUM VALUE (DEG)
10.0	RADIUS OF TOUCH ZONE - MINIMUM (M)
15.0	RADIUS OF TOUCH ZONE - MAXIMUM (M)
15.0	MAXIMUM SAFE GROUND SLOPE FOR A FTZ (PERCENT)
23.0	MAXIMUM SAFE GROUND SLOPE FOR A STZ (PERCENT)
46.0	MAXIMUM SAFE GROUND SLOPE FOR A NTZ (PERCENT)
24.0	CONE INDEX FOR A FTZ, MAXIMUM LOAD (PSI)
2.6	MAXIMUM WIDTH OF CROSS-SECTION OF HULL (M)
13.0	LENGTH OF HULL (M)
13.4	DIAMETER OF ROTOR (M)
2.3	GROUND CLEARANCE OF ROTOR BLADES - STATIC (M)
4.0	GROUND CLEARANCE OF ROTOR BLADES - IDLING (M)
4557.	WEIGHT - EMPTY (LBS)
6596.	WEIGHT - MAXIMUM LOAD (LBS)

* See Reference 4.

Table 3

Data File of Descriptors

for OH-6A Cayuse*

THE HELICOPTER DESCRIBED BY THESE DATA IS THE	
OH-6A CAYUSE	
0	LIFT-OFF CODE (0 = NOT VERTICAL, 1 = VERTICAL)
.24	GROUND CLEARANCE OF HULL (M)
66.0	APPROACH ANGLE (DEG)
22.0	DEPARTURE ANGLE - MINIMUM VALUE (DEG)
90.0	DEPARTURE ANGLE - MAXIMUM VALUE (DEG)
66.0	DEPARTURE ANGLE - MEDIAN VALUE (DEG)
5.25	RADIUS OF TOUCH ZONE - MINIMUM (M)
8.0	RADIUS OF TOUCH ZONE - MAXIMUM (M)
15.0	MAXIMUM SAFE GROUND SLOPE FOR A FTZ (PERCENT)
23.0	MAXIMUM SAFE GROUND SLOPE FOR A STZ (PERCENT)
46.0	MAXIMUM SAFE GROUND SLOPE FOR A NTZ (PERCENT)
10.0	CONE INDEX FOR A FTZ, MAXIMUM LOAD (PSI)
1.39	MAXIMUM WIDTH OF CROSS-SECTION OF HULL (M)
6.95	LENGTH OF HULL (M)
8.03	DIAMETER OF ROTOR (M)
2.13	GROUND CLEARANCE OF ROTOR BLADES - STATIC (M)
0.0	GROUND CLEARANCE OF ROTOR BLADES - IDLING (M)
1800.	WEIGHT - EMPTY (LBS)
2400.	WEIGHT - MAXIMUM LOAD (LBS)

* See Reference 5.

Table 4

Data File of Descriptors

for CH-47A Chinook*

THE HELICOPTER DESCRIBED BY THESE DATA IS THE	
CH-47A CHINOOK	
1	LIFT-OFF CODE (0 = NOT VERTICAL, 1 = VERTICAL)
0.5	GROUND CLEARANCE OF HULL (M)
90.0	APPROACH ANGLE (DEG)
90.0	DEPARTURE ANGLE - MINIMUM VALUE (DEG)
90.0	DEPARTURE ANGLE - MEDIAN VALUE (DEG)
90.0	DEPARTURE ANGLE - MAXIMUM VALUE (DEG)
21.0	RADIUS OF TOUCH ZONE - MINIMUM (M)
26.0	RADIUS OF TOUCH ZONE - MAXIMUM (M)
15.0	MAXIMUM SAFE GROUND SLOPE FOR A FTZ (PERCENT)
23.0	MAXIMUM SAFE GROUND SLOPE FOR A STZ (PERCENT)
46.0	MAXIMUM SAFE GROUND SLOPE FOR A NTZ (PERCENT)
56.0	CONE INDEX FOR A FTZ, MAXIMUM LOAD (PSI)
3.8	MAXIMUM WIDTH OF CROSS-SECTION OF HULL (M)
15.5	LENGTH OF HULL (M)
30.0	DIAMETER OF ROTOR (M)
2.4	GROUND CLEARANCE OF ROTOR BLADES - STATIC (M)
3.4	GROUND CLEARANCE OF ROTOR BLADES - IDLING (M)
17475.	WEIGHT - EMPTY (LBS)
30000.	WEIGHT - MAXIMUM LOAD (LBS)

* See References 6 and 7.

Table 5

Data File of Descriptors

for CH-47C Chinook*

THE HELICOPTER DESCRIBED BY THESE DATA IS THE
CH-47C CHINOOK

0	LIFT-OFF CODE (0 = NOT VERTICAL, 1 = VERTICAL)
0.49	GROUND CLEARANCE OF HULL (M)
90.0	APPROACH ANGLE (DEG)
22.0	DEPARTURE ANGLE - MINIMUM VALUE (DEG)
90.0	DEPARTURE ANGLE - MAXIMUM VALUE (DEG)
66.0	DEPARTURE ANGLE - MEDIAN VALUE (DEG)
26.0	RADIUS OF TOUCH ZONE - MAXIMUM (M)
17.25	RADIUS OF TOUCH ZONE - MINIMUM (M)
15.0	MAXIMUM SAFE GROUND SLOPE FOR A FTZ (PERCENT)
23.0	MAXIMUM SAFE GROUND SLOPE FOR A STZ (PERCENT)
46.0	MAXIMUM SAFE GROUND SLOPE FOR A NTZ (PERCENT)
100.0	CONE INDEX FOR A FTZ, MAXIMUM LOAD (PSI)
3.63	MAXIMUM WIDTH OF CROSS-SECTION OF HULL (M)
15.47	LENGTH OF HULL (M)
18.29	DIAMETER OF ROTOR (M)
2.56	GROUND CLEARANCE OF ROTOR BLADES - STATIC (M)
3.33	GROUND CLEARANCE OF ROTOR BLADES - IDLING (M)
28650.	WEIGHT - EMPTY (LBS)
46000.	WEIGHT - MAXIMUM LOAD (LBS)

* See References 6 and 7.

Table 6

Weight of General-Purpose Bombs Converted to Equivalent Yields in Metric Tons, TNT

Total Weight lb	Explosive Weight lb	Equivalent Explosive Weight, lb, TNT	Equivalent Yield Metric Tons, TNT
15,000	126,000		6.63
12,195*		10,000	4.54
10,000	7,477	8,000	3.63
3,000	1,898		
2,000	945	1,039	0.47
1,000	445		

* Estimated value--under development.

Table 7

Helicopter Variables Used in Program FTJPRH*

Variable Name	Definition	Computer Format
NHELA	Helicopter designation	24A3
HC	Ground clearance of hull	F8.3
AMIN	Departure angle--minimum value	F8.3
AMAX	Departure angle--maximum value	F8.3
RMIN	Radius of touch zone--minimum value	F8.3
RMAX	Radius of touch zone--maximum value	F8.3

* Read from a helicopter data file that is selected by the user.

APPENDIX A: SUGGESTIONS FOR OBTAINING VALUES FOR TERRAIN DESCRIPTORS

1. The terrain data required by the HLZ evaluation procedures are highly specific and detailed. None of them are readily available from conventional sources. In consequence, the user will normally find it necessary to develop his own terrain data for use in the three programs comprising the HLZ evaluation procedure. The following paragraphs contain discussions of some of the methods that might be used to obtain the requisite data, as well as instructions for preparing the data for input to the computer programs comprising the analytical procedure. This specifically includes instructions for filling in the various data input forms:

a. Data input form for FTHEL (Figure 3 in main text).

b. Data input forms for FTJPRH (Figures 6, 8, and 9 in main text).

c. Data input form for FTJPHL (Figure 21 in main text).

Descriptors Required for Program FTHEL

Slope

2. Slope values from topographic maps. Figure A1 is a small section of a conventional topographic map. Since the slope is defined as the angular deviation of the surface from the horizontal, measured perpendicular to the contours, a conventional procedure for measuring slope from a contour map is:

a. Locate the point for which the slope is to be determined (e.g. point a in Figure A1).

b. Find that line connecting the contour lines above and below the point such that it is as close to being perpendicular to both as possible. Because only rarely will two adjacent contour lines be truly parallel, the choice of the exact alignment for the "perpendicular" is to some degree subjective. However, the resultant inconsistencies are normally so small as to be unimportant.

c. Measure the length of the line between the intercepts formed by the points where it crosses the two contour lines. For point a in Figure A1, the value is 9.0 mm. Since the scale of the map is such that 1 mm = 5 m, the length of the line on the ground is 45.0 m.

d. The contour interval of the map is 10 m; thus the elevation difference between the two contour lines is 10 m. Then, assuming that the slope is a plane connecting the two contours, the slope in degrees is

$$S = \arctan \frac{C_i}{D_c}$$

where

C_i = contour interval (elevation difference between contour lines)

D_c = horizontal distance between contour lines

Thus, the slope in degrees at point a is

$$S = \arctan \frac{10}{45} = 12.4 \text{ deg}$$

3. A point such as b in Figure A1 is a bit more complex, since it is difficult to select a line "perpendicular" to the contour lines above and below the point. In such cases, the conventional procedure is:

a. Construct a "ridge line" that runs down the "nose" of the ridge above the point.

b. Construct a line through the point (i.e. b in Figure A1) that is perpendicular to the contour below the point, and extend it beyond the point until it intercepts the ridge line.

c. Measure the length of the ridge line between the two contours above and below point b . In this case, the distance is 25 mm.

d. Measure the distance along the ridge line from the upper contour line to the point at which the line through b intercepts the ridge line. In this case, the distance is 8.5 mm.

e. Then the elevation (E) of a point on the ridge line intercepted by the perpendicular is:

$$E = E_u - \frac{D_u \cdot C_i}{D_m}$$

where

E_u = elevation of upper contour line

D_u = distance along ridge line from upper contour line to intercept with perpendicular line through point b

C_i = contour interval

D_m = distance along ridge line between upper and lower contour lines

$$E = 70 - \frac{8.5(10)}{25} = 66.6 \text{ m}$$

f. Then the slope at point b is given by

$$S = \text{arc tan} \frac{(E - E_\ell)}{D_p}$$

where

E_ℓ = elevation of lower contour line

D_p = distance between lower contour line and E, measured along perpendicular through point b

Thus,

$$S = \text{arc tan} \frac{(66.6 - 70)}{11.0} = 17.2 \text{ deg}$$

4. Slope values from field surveys. Slope values can also be obtained by field surveys, but of course this implies that the site is accessible. If it is, the most convenient method is to simply sight a transit on a leveling rod at a height equal to the height of the instrument, directly up or down the slope (Figure A2). The slope angle can then be read directly from the vertical circle.

5. Slope values from air photos. Slope values can also be obtained from air photos, assuming that stereopairs, as well as certain basic equipment, are available. The details are beyond the scope of this report, but they may be obtained from Reference 11.*

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* Reference numbers refer to similarly numbered items in the References at the end of the main text.

6. Slope values from slope maps. If a large number of sites are to be evaluated in a relatively small area, it may be advantageous to produce a slope map from a conventional topographic map. Many somewhat different manual procedures have been used to produce such maps. However, the procedure that appears to yield the most consistent product is summarized in the following subparagraphs:

a. Subdivide the total range of slopes into the desired categories. For example, six categories might be chosen (the choice is largely subjective) as follows:

Category or Class	Limits, deg	Diameter of Circle, mm
1	0-0.5	45.8
2	0.5-2.0	11.45
3	2-5	4.57
4	5-15	1.49
5	15-30	0.7
6	>30	0.0

b. Construct a set of circles on transparent film, such that there is one circle for the upper limit of each class range. The size of the circle is a function of the map scale and the contour interval. Thus, if the map is at a scale of 1:25,000 and has a contour interval of 10 m, then the diameter of the circle (in millimetres) drawn for class 1 would be obtained by

$$D = \frac{C_i(1000)}{\tan A(S)}$$

where

C_i = contour interval, m

A = angle representing upper limit of slope class

S = denominator of representative fraction of map scale

Then, in the example, class 1 would be

$$D = \frac{10 \cdot 1{,}000}{\tan 0.5(25{,}000)} = 45.8 \text{ mm}$$

c. The circles are then fitted between the contour lines of the map according to the following rule: The interval between contour lines is a given slope class if the circle

representing the slope class will fit between the contour lines, but the next larger circle will not. This principle is illustrated in Figure A1. At the position of the circles, the slope is in class 3.

7. This procedure is by no means objective; much judgment is required in many places. Each analyst tends to develop his own rules of thumb to deal with them. An example of a slope map produced by this method is given in Figure A3.

8. Slope maps can also be produced by automatic data processing; however, the procedure is beyond the scope of this report.

9. Slope maps should be used with caution. Since the total range of slope values must be broken into classes in order to map them, such maps are always mosaics consisting of patches, each of which represents a range of values. Thus, in Figure A3, the total range of slope values has been subdivided into seven unequal categories. It is, of course, impossible to determine the exact slope at a given point. For example, a point in map unit 3 will exhibit a slope greater than 2.0 deg but less than 5.0 deg, but no precision greater than that is possible. It is common to use either the midpoint of the range (in this case, 3.5 deg) or a point near that limit of the class such that the result would be conservative. In the case of HLZ's, steeper slopes are the more difficult, and thus a value near the upper end of the class range might be chosen.

10. Filling in "Data Input Form for FTHEL." The value obtained by any one of the methods described above (or by any other method available to the user) is entered in the last line of Section B (Figure A4). The bottom line of Figure A4 is filled in with the data from point a in Figure A2. Note that the entry must be in degrees.

Cone index

11. Cone index by direct measurement. If the site is accessible to personnel on the ground, it may prove advantageous to measure the cone index directly. This is accomplished with an instrument called a cone penetrometer (Figure A5). It consists of a 30-deg right circular cone having a basal area of 0.5 in.^{2} mounted on one end of a shaft and with a proving ring, dial gage, and handle at the other end.[2] The dial

reads directly in cone index and is graduated from 0 to 300. Figure A5 illustrates the usual mode of operation. The readings at specified depths are averaged to obtain the cone index of the soil at the site of each penetration. More detailed information concerning depths of penetration, averaging, etc., can be found in Reference 13.

12. Since soil strength, as measured by the cone penetrometer, is quite variable, it is usually best to take a number of measurements over the area of concern (in this case, the touchdown area) and average them. This average value can then be entered directly on the data input form (Figure A4).

13. Estimation of cone index from footprints. If no cone penetrometer is available, cone index can be estimated quickly for light-aircraft operations by first measuring the depth of a footprint made by a person walking across the site. With this measurement and the relation in Figure A6,[14] a value of cone index for that footprint depth can be read from the graph. Note that the curve in Figure A6 shows no foot penetration beyond a cone index of 30, so it will not really be satisfactory when evaluating the terrain in terms of heavier aircraft, such as the CH-47, which requires a cone index of 100 for its support. Also, values less than 10 indicate soil that is too soft to support vehicles, equipment, or walking, much less aircraft. Areas with a cone index this low need not be evaluated.[14]

14. Estimating cone index from soil type and moisture content values. Cone index can be estimated by the use of known relations among cone index, soil type, and soil moisture content. The basic relations are shown in Figure A7[15] for five common soil types (classified according to the Unified Soil Classification System[16]). It should be noted that the soils identified in Figure A7 are all fine grained. Coarse-grained soils are not included, since without notable exception, they all exhibit cone indexes greater than 150, regardless of moisture content.[17]

15. Methods of obtaining soil type and moisture content are beyond the scope of this report. Insight into a variety of methods can be obtained by consulting References 15, 18, and 19.

16. Approximating cone index from other soil strength measurements. Cone index has been found to be related to many of the other measured values that are frequently used in determining soil strength. Two of these are the California Bearing Ratio (CBR) and unconfined compressive strength (USC). Having such a relation provides a unique flexibility in that if one of these values is available and cone index cannot be measured directly, the former value can be converted to an approximated value of cone index, as shown in the following tabulation.

Cone Index	CBR	USC psi
45	0.9	4.5
75	1.5	9.0
150	3.0	18.0

Here again, this technique should be used with caution, but a general measure of soil strength can be obtained with it.[18]

17. Filling in "Data Input Form for FTHEL." The value obtained for cone index must be placed in the topmost of the three lines in Section B of the data form (Figure A4).

Microrelief

18. Unlike slope and cone index, microrelief cannot be adequately described by a single value. In fact, because the terrain attributes aggregated under the general term "microrelief" incorporate very complex three-dimensional structures, the description is necessarily somewhat complicated. In the scheme used in FTHEL, microrelief features are assumed to be homogeneously distributed in planimetric space and have at least the semblance of circular form in plan view. Neither of these assumptions is necessarily true in fact, but in most cases the errors introduced by microrelief features that do not meet the assumptions are small enough to be tolerable. This situation occurs because the analysis has deliberately been made conservative.

19. Two basic measurements describe each feature:

a. Height, which is the vertical distance from the highest point of the feature to the lowest point exposed or to the general ground level.

b. Average diameter, which is an "artificial" number. The procedure for obtaining it is to first project the feature vertically downward to the general surface. If the feature is a boulder, the projection can be visualized by its shadow cast with sun directly overhead. If the feature is pyramidal, the projection is equivalent to the base of the pyramid. The longest dimension of the projection is then chosen (Figure A8) and defined as the length. A second dimension is then measured along a line at right angles to the length and so positioned that it is as long as possible. This is the width. Thus, if the object is a football-shaped boulder, the length is the tip-to-tip distance and the width is the diameter at the midpoint. If the feature is a square pyramid, the length and width are then two diagonals of the base. The average diameter is the average of the length and width.

20. It is easier to keep track of the bookkeeping in the process of describing microrelief features if the "Microrelief Data" form (Figure A9) is used. Note that one sheet is used for each height class. The column headings are self-explanatory.

21. Because a very large number of individual microrelief features may be present, the features are grouped for purposes of description into height classes as follows:

Height Class	Range m
I	<0.3
II	>0.3-1
III	>1-2
IV	>2-3
V	>3-4
VI	>4

In many cases, all features in the same height class will tend to exhibit the same general shape, but this is not always the case. It is possible to have a site with termite mounds, stumps, and boulders, all of roughly the same height. The form permits such diverse features to be described individually or aggregated in any way that seems appropriate to the analyst.

22. At this point, it is necessary to determine the radius of the "sample cell." To obtain this number, all of the features in the

height class are examined, and the circular area which is large enough to include 20 features is selected (Figure A8). This circular area is called the "sample cell"[12] for the height class. This value is placed in the blank on the top of the "Microrelief Data" form opposite the notation "Sample Cell Radius, m." For the sample data in Figure A9, the value "25" has been placed in the appropriate place. Note that this number cannot be derived from the data on the "Microrelief Data" form; it can only be obtained from a plot of feature distributions, as illustrated in Figure A8.

23. As stated in the preceding paragraph, the data are assembled one height class at a time. After all of the features in a single height class have been recorded in the "Microrelief Data" form (e.g. Height Class VI in Figure A9), an inspection of all the recorded height values will reveal the largest value in each height class. Note that this is not necessarily the same as the upper limit of the height class; in most instances it will be a bit less. This maximum value is placed in the blank at the bottom of the "Microrelief Data" form, opposite the notation "Maximum height in this class." For example, an inspection of the sample data in Figure A9 will reveal that the greatest height actually recorded in the "Height" column is 4.5 cm.

24. The average diameter of all of the features in the height class is then calculated, and the value is then placed in the blank at the bottom of the "Microrelief Data" form opposite the notation "Average diameter for this class." For example, the sample data in Figure A9 yield 50 cm as the average diameter.

25. Finally, all of the numbers in the "Number Present" column of the "Microrelief Data" form are added, and the resultant sum is placed in the blank opposite the notation "Total number features" at the bottom of the page. The form (Figure A9) must be completed for each microrelief height class present at the site.

26. On-site measurement. The most straightforward and reliable method for obtaining microrelief data is to measure the features on the ground, and this method should be used if the site is accessible to survey parties. The example used in this report makes use of field

data. Often the site is not accessible to ground parties; therefore, data must be inferred from indirect sources. The accuracy of the inference is largely dependent on the supportive data available and the skill of the terrain analyst. For example, the analyst makes estimates of microrelief by using terrain analogs or by air-photo interpretation as discussed in the following paragraphs.

27. Estimation by terrain analogs. This technique is based on the principle that geographically separated regions tend to exhibit the same characteristics if they have been subjected to the same developmental history. Thus, the procedure is to determine the general characteristics of the site, including rock types, local relief, climate, and land use, and then to find another place having essentially the same characteristics, but in an accessible location. An on-site description of the microrelief of the accessible site is then assumed to be an approximate analog of the inaccessible site. The principles of this technique are developed in Reference 20. It is helpful if the "alikeness" of the two areas can be established by air reconnaissance, local residents, or other supplementary means.

28. Estimation by air-photo interpretation. If the ground surface can be seen from the air, it is sometimes possible to obtain highly reliable descriptions of microrelief from air photos. The procedures are relatively complex and subtle. They are discussed in some detail in Reference 8.

29. Filling out "Data Input Form for FTHEL." When "Microrelief Data" forms for all height classes present on the site have been completed (paragraphs 23-25), the data in the three blanks at the bottom of each form (Figure A9) are transferred to the "Data Input Form for FTHEL" (Figure A4). For example, using the data in the example in Figure A9, the "Height Class VI" column in Section A in the "Data Input Form for FTHEL" would appear as in Figure A4.

30. Finally, an examination of the numbers opposite the "Sample Cell Radius" notation on the "Microrelief Data" forms (Figure A9) for all height classes will reveal the largest such value. This value is entered in the middle line of Section B of the data form (Figure A4).

For example, if the 25 entered in Figure A9 is the largest number in all of the height classes, the number entered on the "Input Data Form for FTHEL" would be 25, as illustrated in the example in Figure A4.

Descriptors Required for Program FTJPRH

31. Since the reliability of the remnant height profiles generated by program FTJPRH largely depends upon the accuracy of the vegetation descriptions, it is important that the data forms (Figures 6, 8, and 9 in main text) be filled in with great care.

Format 1 data

32. The Format 1 data form (Figure 6 in main text) is designed to accept data collected under conditions in which very detailed information on every tree in the stand can be readily obtained. These data represent the most specific conditions and result in the most accurate remnant height profile.

33. It will be noted that the data form calls for three pieces of information not specifically related to the vegetation.

- a. Site identification. This is not used in the program; it is included on the data form only to assist the user in keeping his records straight.
- b. Weapon yield. This must be stated in terms of yield in metric tons, as discussed in paragraphs 43-45 in the main text.
- c. Output file name. The importance of this item is discussed in paragraph 52 of the main text and in Appendix E.

34. The numbered items on the Format 1 data form are devoted to tree descriptors.

- a. Item 1 is the common name of the tree species being described. This information is not used in the program except as a record-keeping device. It is printed out at the head of the Format 1 output (bottom of sheet 4 of Figure 15 in main text) to make it easier for the user to match the evaluation with the original data form. The only restriction is that the name not exceed 39 characters. The user need not use a common name; if the identification on the data form is a Linnaean name, that will do just as well.

b. Item 2 is a tree identification number. This number, which is assigned by the user, is not used in the computation but is returned at the head of the program output (bottom of sheet 4 of Figure 15 in main text) as an aid to the user. Any 3-digit number can be used. As noted previously (see paragraph 39a in main text), Format 1 evaluations deal with one tree at a time, and each tree evaluated should be assigned a different number.

c. Item 3 is the modulus of rupture stated in dynes per square centimetre ($dynes/cm^2$). These are very large numbers. For example, the American elm has a modulus of rupture of 496,400,000 $dynes/cm^2$. To make data input somewhat easier, the program accepts such large values only in exponential notation. However, since the computer does not have standard superscript characters, a special format must be used:

$$496{,}400{,}000 = 4.964 \times 10^8 = 4.964E{+}8$$

The last set of characters, 4.964E+8, is the correct input format. It is the only format that the program will accept. Tables A1 and A2 show a number of common tree species and their associated properties. If the tree species for which an evaluation is desired is listed in the tables, the easiest method of filling in the Format 1 data form is to extract the appropriate number from the tables. If the species of interest does not appear in either of these lists and no other source is available, values for a species that closely resembles the one in the area can be substituted as long as a certain degree of caution is used when the output is interpreted. If other sources are used, it is possible that the values will be expressed in U. S. customary units, so conversion will be necessary prior to completing the form. The necessary conversion factor is:

$$1 \text{ psi} = 68{,}950 \text{ dynes/cm}^2$$

d. Item 4 is Young's modulus, stated in dynes per square centimetre ($dynes/cm^2$). This value can also be found for many species in Tables A1 and A2. It should be noted that many sources use "modulus of elasticity" as a synonym for Young's modulus.

e. Item 5 can be provided in two forms: wood density in grams per cubic centimetre (gm/cm^3), or as a combination

of specific gravity and moisture content. All three values are given in Tables A1 and A2.

f. Item 6 is the diameter of the stem measured at a height of 1 m above the base. If the ground is reasonably horizontal (as it must be to provide an acceptable helicopter landing zone), the elevation selected as the base is usually clear enough so that no problem occurs. However, if the tree is growing on a significant slope, the elevation of the base is often a matter of judgment. In general, it is better to pick the point too low than too high. This will give a more conservative estimate of remnant height.

g. Item 7 is the height of the tree in metres. This value can be obtained by direct measurement in the field.

h. Item 8 provides data on the location of the tree with respect to GZ. Three options are available:

(1) If item 8a is chosen (by indicating YES on the data form), the program will position the tree described on the data form at intervals of 1 m from GZ and record the remnant height of that tree at each 1-m interval (see paragraph 62 in main text). If the choice is NO, the user must provide data in either item 8b or item 8c.

(2) If the stand exhibits several trees of a particular species and of the same size, it is usually best to select the option specified in item 8b. In this case, the user must first note the number of trees in the set (i.e. all of those of the same species and size) and place that number in the blank opposite the notation "No. locations:" On the lines below, the user must then list, in ascending order, the distance from GZ to each tree in the set. The number of notations must match the value placed in the "No. locations:" blank. While only six lines are provided on the data form, a total of 115 distances can be input at one time.

(3) The third option can also be used if there are several trees of the same species and size in the stand, but in this option (indicated by item 8c in the data form), the position of the trees is indicated by XY-coordinates. The user must first provide the number of pairs of XY-coordinates in the set by placing the proper number in the blank opposite the notation "No. locations:" on the data form. On the top line of the set of six lines devoted to the coordinates, place the XY-coordinates of GZ. This is absolutely essential. Following the specification of GZ, as many as 115 tree locations can be specified. The easiest method of providing the XY-coordinates is

to place an arbitrary coordinate system over a plot of the tree stems, such that all of the stems in the site are in the first quadrant. This makes all XY-values positive. The program calculates the radial distance from the GZ coordinates to each pair of tree coordinates and arranges them in order of increasing distance. The result is that the program derives the same data as the user provided in item 8b.

35. The data required for Format 1 are the most difficult to obtain, but the output produced when these data are used presents the most complete information to evaluate the site as a landing zone. Each tree species of a single stem diameter and tree height is analyzed as an entity, and often several species occur with several diameters, heights, strengths, etc; these evaluations yield vegetation profiles that can be readily superimposed on a plot to obtain a comprehensive vegetation profile of the site. This profile can be studied to determine which trees limit the use of the site for the specific helicopter being evaluated.

Format 2 data

36. The Format 2 data form (Figure 8 in main text) is designed to accept vegetation descriptors that in general tend to reflect the most severe condition in the site. The advantage is that it permits a very rapid and conservative evaluation of a site in a single computer run.

37. The data form initially calls for a site identification, weapon yield, and output file name, as discussed in paragraph 33. Only three vegetation descriptors are required.

a. Item 1 is the maximum wood strength class occurring in the site. For realistic estimates, every tree species that occurs in the site must be known. The user then examines Tables A1 and A2 to find the largest strength class (last column on the right) in the site. For example, if the site contains black ash, white ash, and blue beech, the value placed in this item would be 5. It should be noted that in some instances the strongest tree might have such a small stem diameter that the evaluation of the site cannot be based solely on this tree. In this case, other strength and stem diameter combinations can be used in the program to ensure that the critical combination has been evaluated. If the species are not listed in Tables A1 and A2, the user can assign a strength class

using one of the two following techniques:

(1) Strength classes may be assigned on the basis of the ratio

$$S\rho/E$$

where

S = modulus of rupture, lb/in.^{2} (dynes/cm^2)

ρ = density of the wood, lb/ft^3 (grams/cm^3)

E = Young's modulus of elasticity, lb/in.^{2} (dynes/cm^2)

Table A3 is a list of the strength class ranges. To use this technique, a value for the ratio is computed and placed in the proper range in Table A3, and the corresponding strength class is assigned.

(2) If the specific wood strength properties are not available, a second technique can be used that provides a generalized estimate of strength class. Figures A10 and A11 are graphic presentations of the relation between wood density and wood strength represented by the ratio $S\rho/E$. In Figure A10 are plotted species located in temperate areas, corresponding to Table A1; Figure A11 consists of species located in tropic areas, corresponding to Table A2. The equation of the line of linear regression is written on each plot. If the user cannot locate the strength properties for a given species, it is often easier (and requires less equipment) to obtain the wood density by direct measurement than to measure the wood strength. The wood density can be input into the proper equation (Figures A10 and A11) to compute wood strength. Using this value, he can then repeat the process described above by referring to Table A3. This is a very rough estimate of strength class, and the user must be continuously aware of this fact. An important note is that Figures A10 and A11 are plotted in U. S. customary units since the measurements for wood density will most likely be expressed in these units.

b. Item 2 is the maximum stem diameter in the maximum wood strength class. To provide this number, the user searches for the largest stem diameter exhibited by the species exhibiting the highest wood strength class. In the example given in item 1, the user would look for the largest blue beech in the site and place its stem diameter in centimetres in the blank opposite item 2 in the data form.

c. Item 3 is the maximum tree height in the maximum wood strength class. Again using the same example, the user

would search for the tallest blue beech in the site and place its height (stated to the nearest tenth of a metre) in the blank opposite item 3 in the data form.

Format 3 data

38. The Format 3 data form (Figure 9 in main text) is used when the vegetation description is available in more detail than that needed for Format 2 and yet not as specific or complete as that required for Format 1. The tree data used to complete this form must first be placed into appropriate strength classes and then into appropriate diameter classes. There are six strength classes. The determination of diameter classes is a bit more complex and in practice should only be done with the aid of the matrix on the bottom of the Format 3 data form. It should be noted that the range of values in each diameter class is not necessarily the same in each strength class. For example, a tree 9.5 cm in diameter having a strength class of 1 will fall in diameter class 3; but if a 9.5-cm tree has a strength class of 2, it will fall in diameter class 2. A peculiarity of the mathematics in the evaluation routine is responsible for the apparent lack of parallelism in the limits defining diameter classes.

39. The following procedure is to be used in filling in the Format 3 data form. First, consider all of the trees at the site that have stem diameters of less than 7 cm. These trees (matrix on bottom of the form) will all be in diameter class 1. When all diameter class 1 trees have been identified, determine the strength class of each tree. Let us suppose that all of the diameter class 1 trees are northern white cedar and that, therefore, they are all characterized by strength class 1 (Table A1). We now look for the largest stem diameter in the class and the tallest tree in the class. Let us assume that the largest stem diameter is 7 cm and the tallest tree of the class is 8.0 m tall. In the data form for Format 3, there are pigeonholes for values describing the maximum diameter and the maximum height of diameter-class-1 wood-strength-class-1 trees. The maximum stem diameter (7 cm) is placed in the upper pigeonhole, and the maximum height (8.0 m) is placed in the lower pigeonhole, as illustrated in Figure A12.

40. Let us now look at all diameter class 2 trees, and fill in the form appropriately. In the example, the maximum stem diameter was 9 cm and the maximum height was 10.0 m.

41. The diameter class 3 trees are obviously of two different kinds, since some of them are wood strength class 1 and others are of wood strength class 6. In the example in Figure A12, the largest stem diameter exhibited by a tree having a diameter class of 3 and a wood strength class of 1 is 14 cm. The highest tree having similar stem diameter and wood strength classes is one 15.0 m tall. On the other hand, the largest stem diameter exhibited by a tree having stem diameter class 3 and wood strength class 6 is 15 cm, and the tallest tree in similar classes is 15.0 m tall.

42. Note that it is not necessary to fill every pigeonhole in the data form. Program FTJPRH requests data for each strength class beginning with class 1 and proceeding consecutively to class 6. When no data are available in a specific pair of pigeonholes (as, for example, the two representing diameter class 1 and wood strength class 2 in Figure A12), the user enters 0,0 at the place where the program requests data for that diameter and wood strength class.

43. If the strength class is unknown, a value must be obtained by one of the methods described in paragraph 37.

Descriptors Required for Program FTJPHL

44. The data form for program FTJPHL (Figure A13) requires only two items of terrain data not previously required; namely, the number of trees/100 m^2 and the common names of the tree species in the site. As discussed in the following paragraphs, the first value is essential to the calculations and should be obtained with some care.

Number of trees per unit area

45. The most reliable means of obtaining this value is through on-site sampling. The number of trees/100 m^2 for the diameter class and strength class represented on the remnant height file can be determined by selecting a representative area of the site and counting

the number of stems. If the selected area is greater or less than 100 m^2, the number of stems must be proportioned to a 100-m^2 area. The equation[13] to be used is

$$\text{No. of stems}/100\ m^2 = N\left(\frac{100}{A}\right) \tag{A1}$$

where

N = number of stems for a specified diameter class and strength class

A = sample area (m^2) from which N was obtained

46. Another method that can be used to determine this value is to use the "structural cell" concept of vegetation characterization.[12] A structural cell is defined as the minimum circular area that includes 20 stems of a specified diameter class and strength class. Using this concept causes Equation A1 to become

$$\text{No. of stems}/100\ m^2 = 20\left(\frac{100}{A_i}\right)$$

where

A_i = area (m^2) of the structural cell for the specified diameter class and strength class

47. If the site cannot be visited (and, of course, it will be impractical in many military situations to do so), then less direct and less accurate methods must be used. There is abundant literature devoted to the description of the physiognomic characteristics of vegetation assemblages and tree stands in particular. Even a representative sample of such publications is far too extensive to list in this report. While many of them are concerned with on-site sampling, others include more or less extensive discussions of procedures for estimating physiognomic characteristics by indirect means, including site analogies and air-photo interpretation. A very limited number of such publications[10, 21-24] is included.

<u>Species of trees</u>

48. As noted in paragraph 34<u>a</u>, the tree species names are not

presented in the calculations. They are included only to complete the site record and to serve as a mnemonic for the user. In consequence, the user could use nonsense words, if they served his purpose. On the other hand, if species names are being used as a kind of code to help him identify different kinds of sites, it would be useful to provide valid names. In this case, it is often helpful to obtain a flora of the region, if one has been published. Many publications devoted exclusively to tree identification exist such as References 25 and 26. They are usually restricted to nations or regions.

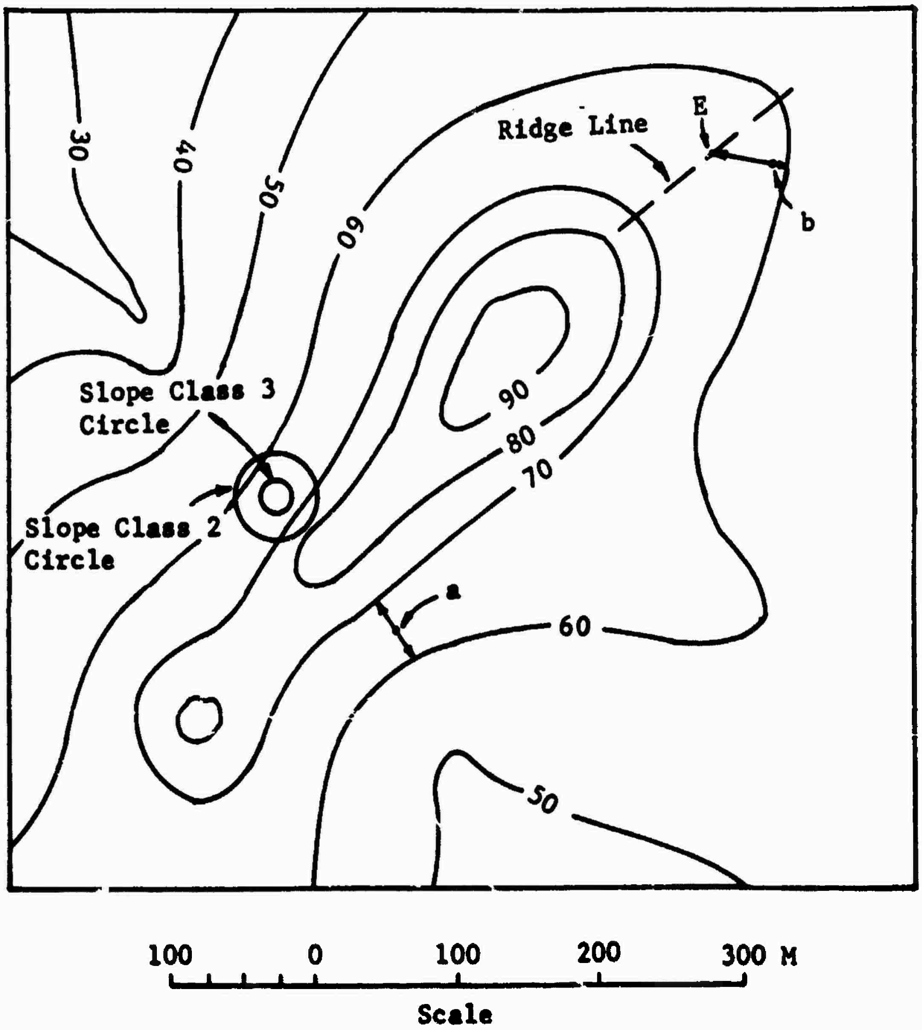


Figure A1. Section of conventional topographic map

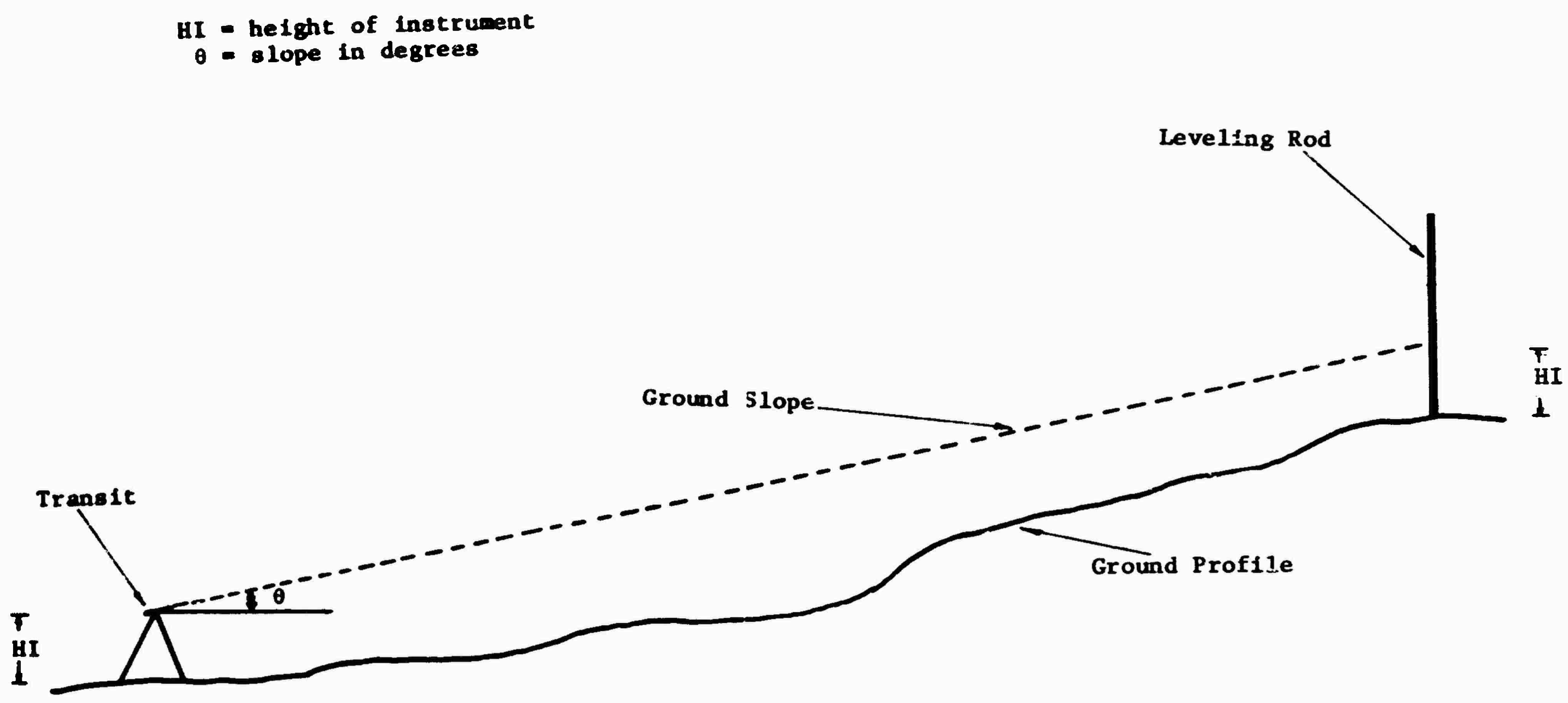
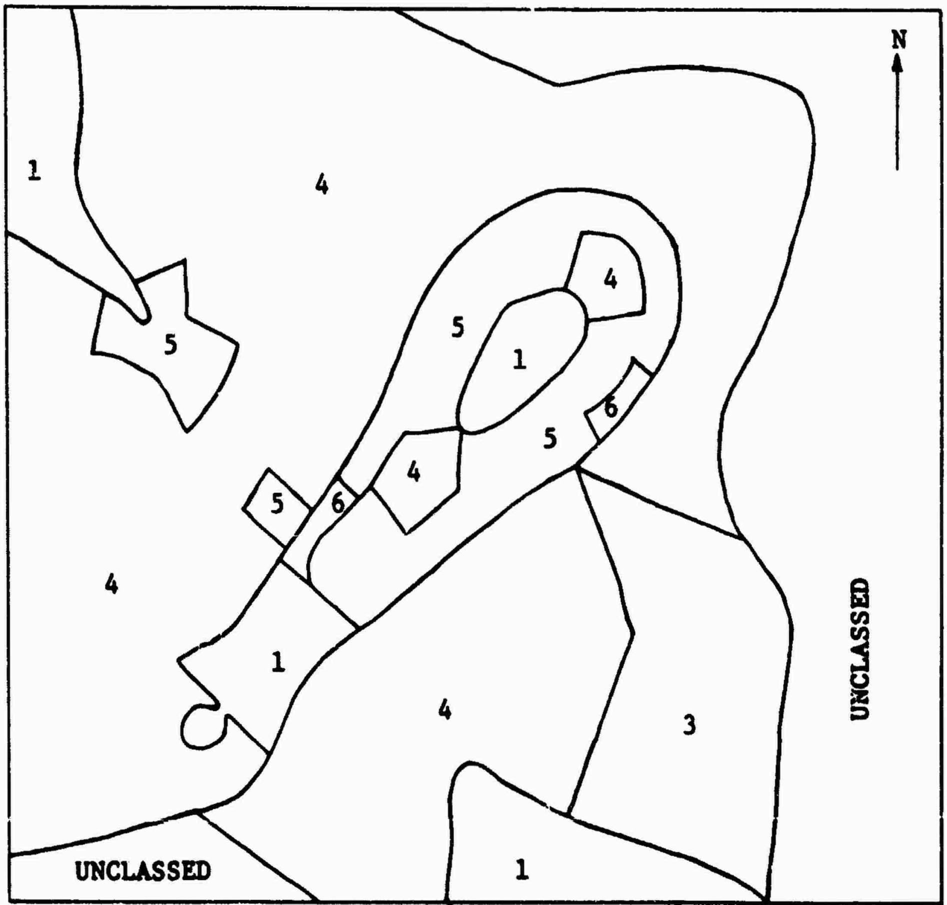


Figure A2. Measuring ground slope with transit and leveling rod



LEGEND

Unit	Slope Class Ranges, deg
1	0 - 0.5
2	>0.5 - 2.0
3	>2.0 - 5.0
4	>5.0 - 15.0
5	>15.0 - 30.0
6	>30.0

Figure A3. Portion of slope map

A. Microrelief Feature Data

	Height Class I	Height Class II	Height Class III	Height Class IV	Height Class V	Height Class VI
Height of upper limit of each class	—	—	—	—	—	4.5
Average diameter of microrelief features in each class	—	—	—	—	—	50
Number of features in each class	—	—	—	—	—	20

B. Additional Terrain Descriptors

45 Cone index, psi

25 Radius of largest sample cell of microrelief features that are homogeneously distributed, m

12.4 Ground slope, deg

Figure A4. Data input form for FTHEL

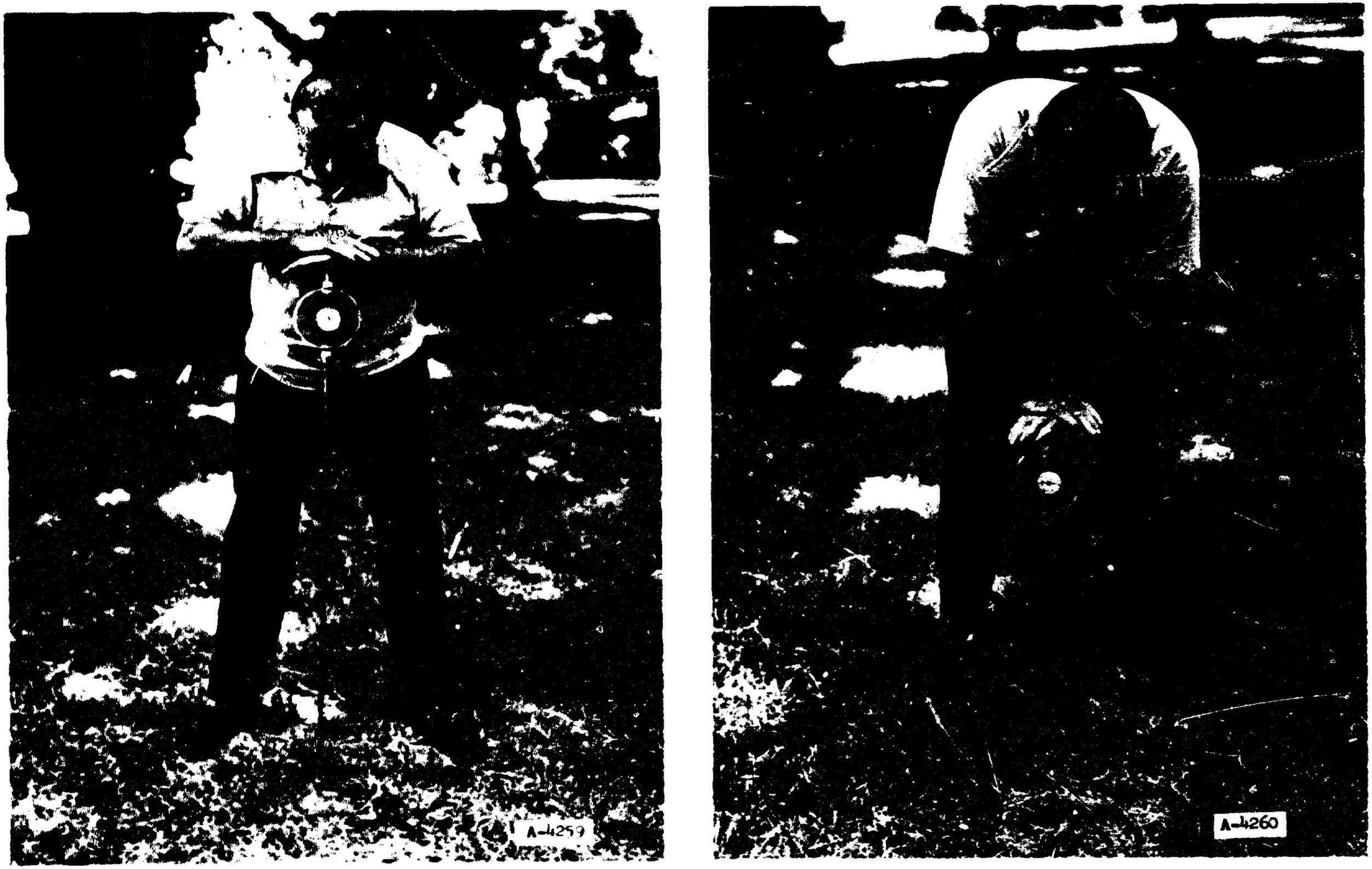


Figure A5. Demonstrating use of the cone penetrometer

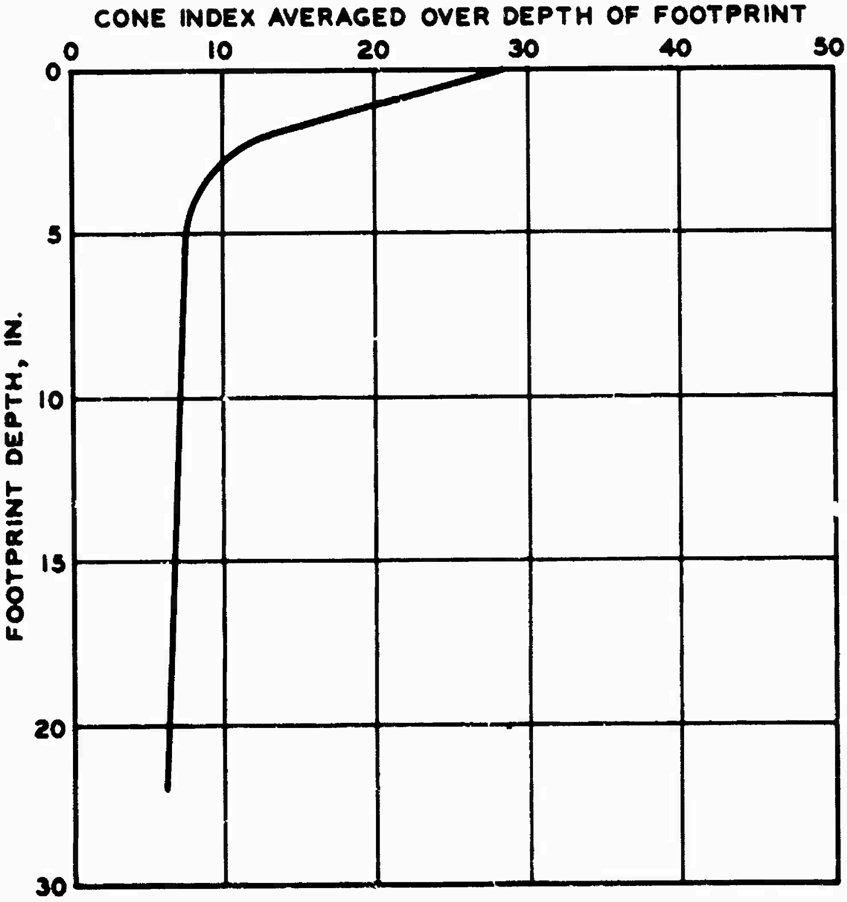


Figure A6. Graphic determination of cone index from footprint depth (Reference 14)

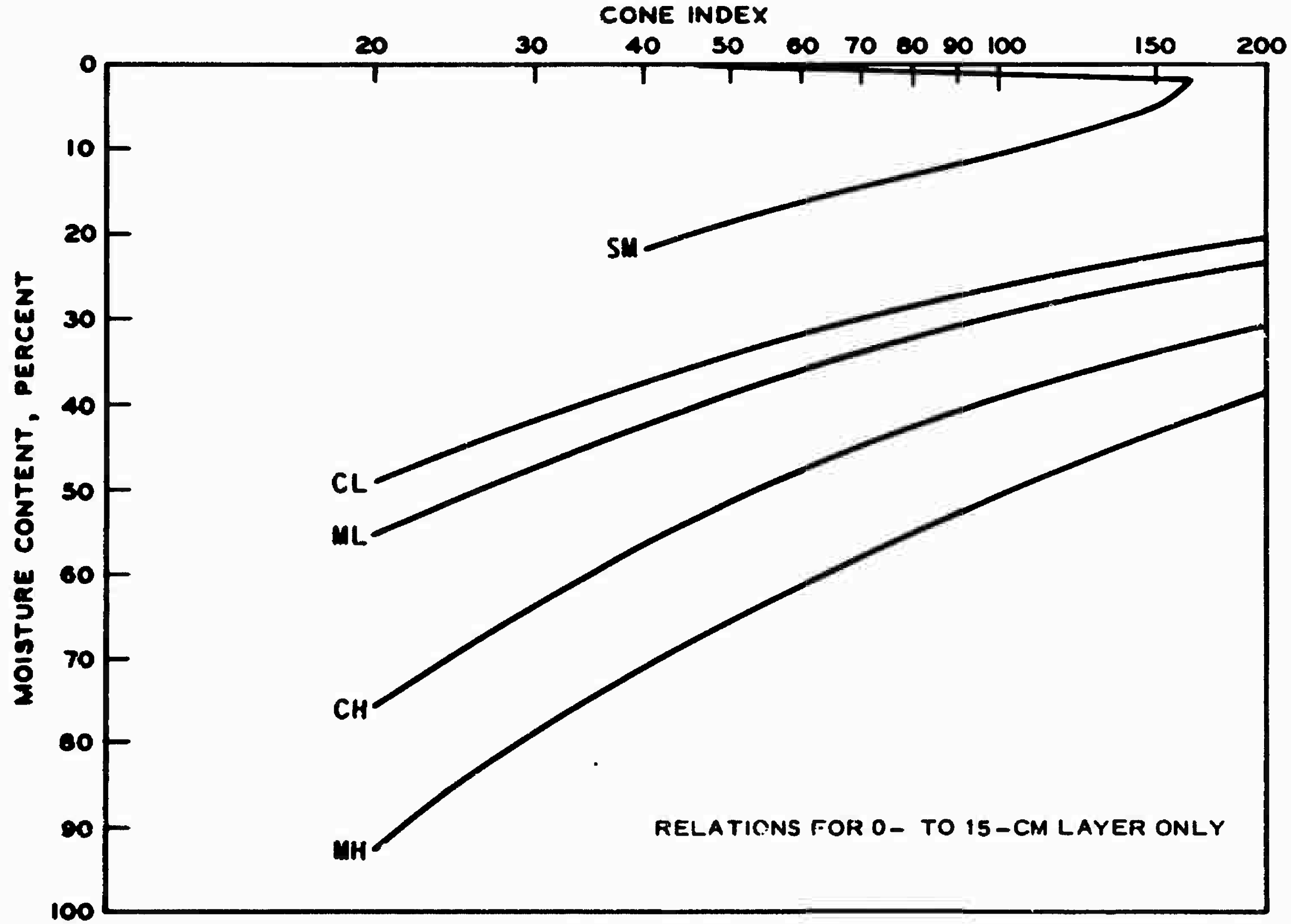


Figure A7. Relation of cone index, soil type, and moisture content (Reference 15)

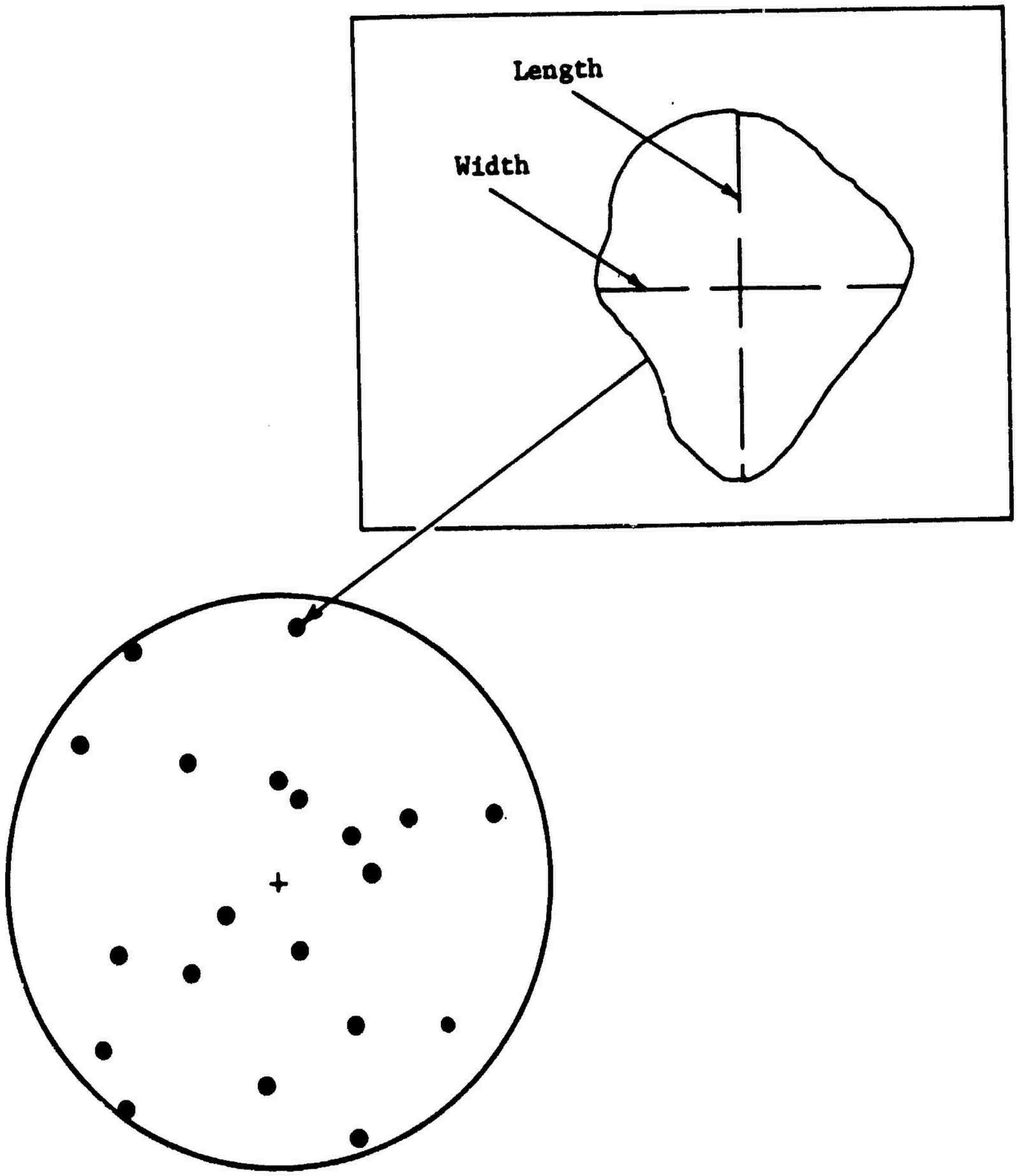


Figure A8. Diagram of a sample cell for one height class of microrelief features with an inset of the plan view of a single feature

Microrelief Data

Height Class . VI   Sample Cell Radius, m 25

Feature No.	Height cm	Width (W) cm	Length (L) cm	Average Diameter* cm	Number Present
1	4.1	45	63	54	5
2	4.5	40	46	43	1
3	4.2	61	61	61	3
4	4.3	45	57	51	1
5	4.5	35	71	53	1
6	4.1	40	50	45	2
7	4.1	33	35	34	2
8	4.4	45	55	50	3
9	4.1	36	56	46	2

Maximum height in this class 4.5

Average diameter for this class 50

Total number features 20

* $\frac{L + W}{2}$ is the equation for average diameter.

Figure A9. Example of completed form for microrelief features

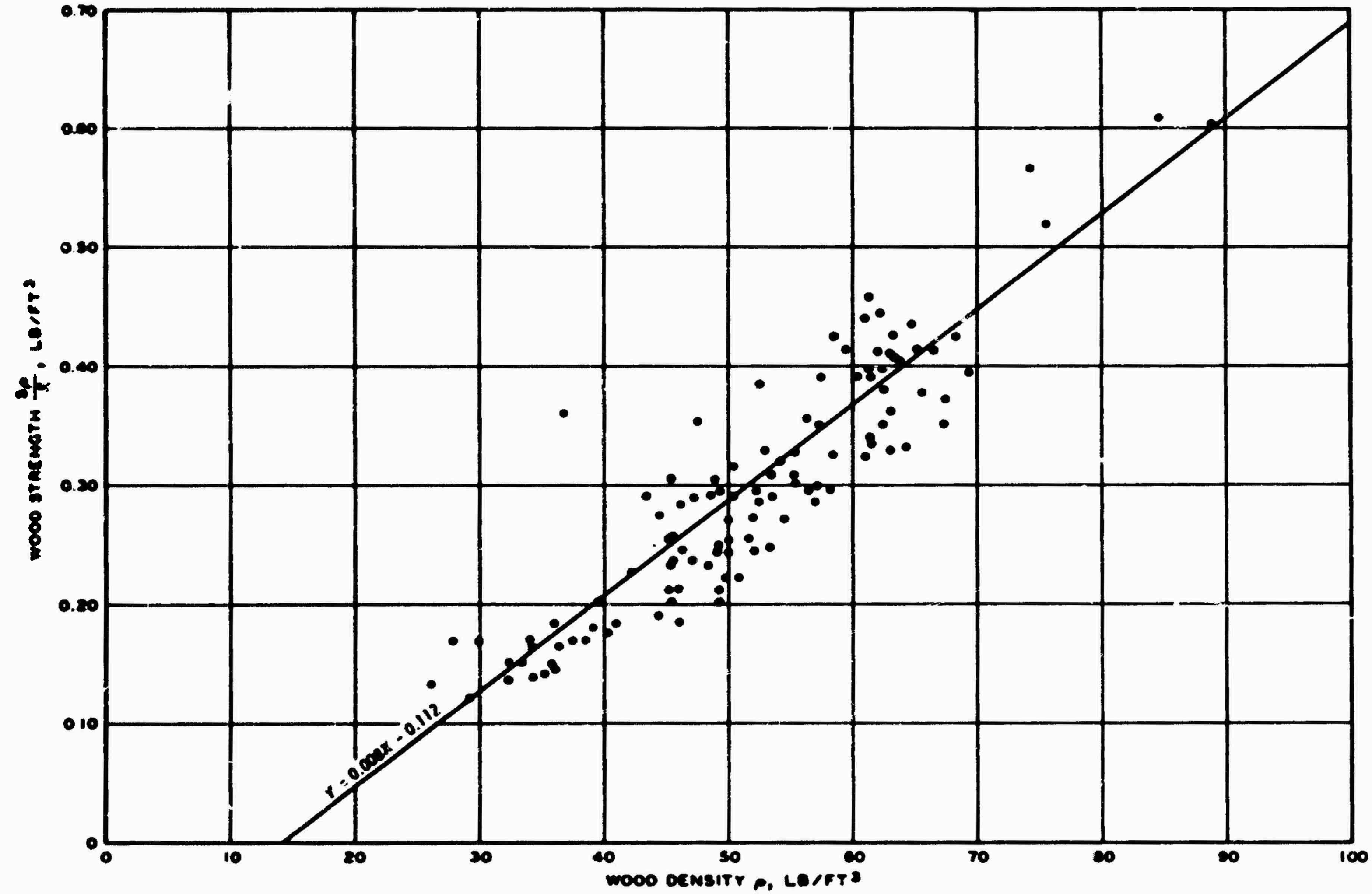


Figure A10. Linear relation between wood strength and wood density in temperate areas

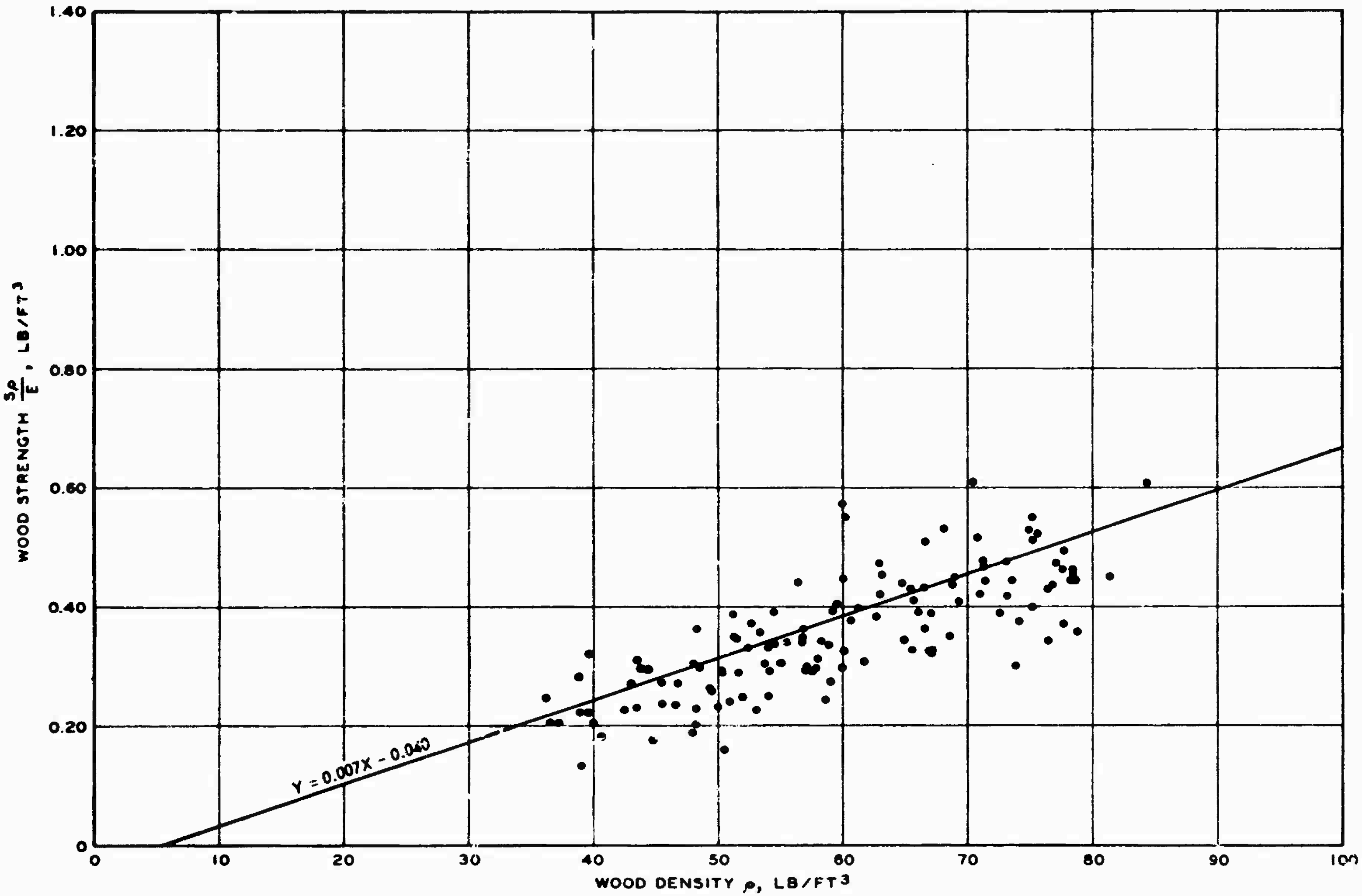


Figure A11. Linear relation between wood strength and wood density in tropic areas

Vegetation Input Data Format 3

Site SS-04

Weapon yield 3.63 Output file name RHF5

	Diameter Class		Wood Strength Class 1	2	3	4	5	6
Maximum Stem Diameter and Tree Height	1	Diam, cm	7					
		Height, m	8.0					
	2	Diam, cm	9					
		Height, m	10.0					
	3	Diam, cm	14					15
		Height, m	15.0					15.0
	4	Diam, cm	18	18		16		
		Height, m	12.0	12.0		9.6		
	5	Diam, cm	23	24				25
		Height, m	13.5	10.0				13.0
	6	Diam, cm	34					
		Height, m	18.0					
	7	Diam, cm	46					
		Height, m	16.5					
	8	Diam, cm	68					76
		Height, m	20.0					20.0
	9	Diam, cm	85					
		Height, m	25.0					

DIAMETER CLASS RANGES

Diameter Class	Strength Class 1	2	3	4	5	6
1	0-7	0-7	0-7	0-7	0-7	0-7
2	7-9	7-10	7-10	7-10	7-10	7-10
3	9-14	10-14	10-15	10-15	10-15	10-15
4	14-18	14-19	15-20	15-20	15-20	15-20
5	18-23	19-24	20-24	20-25	20-25	20-25
6	23-34	24-36	24-37	25-38	25-38	25-38
7	34-46	36-48	37-49	38-50	38-50	38-51
8	46-68	48-72	49-73	50-75	50-75	51-76
9	68-85	72-91	73-91	75-94	75-94	76-95

Figure A12. Example of filled-in Format 3 data form

Input Data Summary for Program FTJPHL

Sample No.	______
Helicopter	______
Touch zone radius, m	______
Departure angle, deg	______
Landing zone design	______
Remnant height file name	______
Weapon yield, metric tons TNT	______
Number of trees/100 m^2*	______
Number of species*	______

Common names of species:

(1) ______	(11) ______
(2) ______	(12) ______
(3) ______	(13) ______
(4) ______	(14) ______
(5) ______	(15) ______
(6) ______	(16) ______
(7) ______	(17) ______
(8) ______	(18) ______
(9) ______	(19) ______
(10) ______	(20) ______

* For the trees of the diameter and strength class represented by the remnant heights on the file named above.

Figure A13. Input data form for program FTJPHL

Table A1

Strength Properties of Certain Tree Species Occurring in the United States

Common Name of Tree Species	Modulus of Rupture S dynes/cm^2	Young's Modulus E* dynes/cm^2	Specific Gravity, SG**	Moisture Content, %	Wood Density ρ g/cm^3	Strength Class
Alder, Red	4.482 E+8	8.8670 E+10	0.37	98	0.73	2
Ash						
Black	4.137 E+8	7.8810 E+10	0.45	85	0.83	3
Green	6.550 E+8	1.0611 E+11	0.53	48	0.78	3
Oregon	5.240 E+8	8.5636 E+10	0.50	48	0.74	3
White	6.619 E+8	1.1066 E+11	0.55	42	0.78	3
Aspen, Bigtooth	3.723 E+8	8.4946 E+10	0.41	99	0.82	2
Aspen, Quaking	3.516 E+8	6.5160 E+10	0.35	94	0.68	2
Baldcypress	4.551 E+8	8.9428 E+10	0.42	91	0.80	3
Basswood, American	3.448 E+8	7.8810 E+10	0.32	105	0.66	1
Beech, American	5.930 E+8	1.0460 E+11	0.56	54	0.86	3
Beech, Blue	4.687 E+8	7.5087 E+10	0.72	48	1.07	5
Birch						
Paper	4.413 E+8	8.8670 E+10	0.48	65	0.79	2
Sweet	6.480 E+8	1.2508 E+11	0.60	53	0.92	3
Yellow	5.723 E+8	1.1370 E+11	0.55	67	0.92	3
Black Gum	4.826 E+8	7.1018 E+10	0.55	55	0.85	4
Black Ironwood	1.131 E+9	1.6686 E+11	1.08	32	1.43	6
Butternut	3.723 E+8	7.3501 E+10	0.36	104	0.73	2
Cedar						
Alaska	4.413 E+8	8.6394 E+10	0.42	38	0.58	1
Atlantic White	3.241 E+8	5.6815 E+10	0.31	55	0.48	1
Eastern Red Cedar	4.826 E+8	4.9230 E+10	0.44	35	0.59	4
Incense	4.275 E+8	6.3641 E+10	0.35	108	0.73	3

(Continued)

* Parallel to stem.

** Based on weight when oven-dry and volume when green.

Table A1 (Continued)

Common Name of Tree Species	Modulus of Rupture S dynes/cm^2	Young's Modulus E dynes/cm^2	Specific Gravity, SG	Moisture Content, %	Wood Density, ρ g/cm^3	Strength Class
Cedar (Continued)						
Northern White	2.896 E+8	4.8472 E+10	0.29	55	0.45	1
Port Orford	4.275 E+8	1.0763 E+11	0.40	43	0.57	1
Western Red Cedar	3.516 E+8	6.9708 E+10	0.31	37	0.42	1
Cherry, Black	5.516 E+8	9.9288 E+10	0.47	55	0.73	3
Chestnut, American	3.861 E+8	7.0467 E+10	0.40	122	0.89	3
Cottonwood						
Black	3.310 E+8	8.1085 E+10	0.32	132	0.74	1
Eastern	3.654 E+8	7.6534 E+10	0.37	111	0.78	2
Cucumbertree	5.102 E+8	1.1825 E+11	0.44	80	0.79	2
Dogwood	6.068 E+8	8.9497 E+10	0.64	62	1.04	5
Douglas Fir						
Coast Type	5.240 E+8	1.1901 E+11	0.45	38	0.62	1
Intermediate Type	4.689 E+8	1.0232 E+11	0.41	48	0.61	1
Rocky Mountain Type	4.413 E+8	8.9428 E+10	0.40	38	0.55	1
Elm						
American	4.964 E+8	8.4119 E+10	0.46	89	0.87	3
Cedar	6.343 E+8	8.8670 E+10	0.59	60	0.94	5
Rock	6.550 E+8	9.0187 E+10	0.57	48	0.84	4
Slippery	5.516 E+8	9.3220 E+10	0.48	85	0.89	4
Winged	6.343 E+8	9.1704 E+10	0.60	59	0.95	5
Fir						
Balsam	3.379 E+8	7.2742 E+10	0.34	117	0.74	2
California Red	4.137 E+8	9.1704 E+10	0.37	116	0.80	2
Grand	4.206 E+8	9.8530 E+10	0.37	94	0.72	1
Noble	3.999 E+8	9.6254 E+10	0.35	36	0.48	1
Pacific Silver	3.930 E+8	9.5496 E+10	0.35	66	0.58	1
White	3.930 E+8	7.8051 E+10	0.35	115	0.75	2

(Continued)

Table A1 (Continued)

Common Name of Tree Species	Modulus of Rupture S dynes/cm^2	Young's Modulus E dynes/cm^2	Specific Gravity, SG	Moisture Content, %	Wood Density ρ g/cm^3	Strength Class
Hackberry	4.482 E+8	7.1984 E+10	0.49	65	0.81	3
Hemlock						
Eastern	4.413 E+8	8.1085 E+10	0.38	111	0.80	3
Western	4.206 E+8	9.2462 E+10	0.38	74	0.66	1
Hickory, Pecan						
Bitternut	7.102 E+8	1.0611 E+11	0.60	66	1.00	5
Nutmeg	6.274 E+8	9.7771 E+10	0.56	74	0.97	4
Pecan	6.757 E+8	1.0384 E+11	0.60	63	0.98	4
Water	7.378 E+8	1.1825 E+11	0.61	80	1.10	5
Hickory, True						
Mockernut	7.653 E+8	1.1901 E+11	0.64	59	1.00	5
Pignut	8.067 E+8	1.2508 E+11	0.66	54	1.02	5
Shagbark	7.584 E+8	1.1901 E+11	0.64	60	1.02	5
Shellbark	7.240 E+8	1.0156 E+11	0.62	61	1.00	5
Honeylocust	7.033 E+8	9.7771 E+10	0.60	63	0.98	5
Larch, Western	5.654 E+8	1.1597 E+11	0.51	58	0.81	2
Locust, Black	9.515 E+8	1.4024 E+11	0.66	40	0.92	4
Magnolia, Southern	4.689 E+8	8.4119 E+10	0.46	105	0.94	4
Maple						
Bigleaf	5.102 E+8	8.3361 E+10	0.44	72	0.76	3
Black	5.447 E+8	1.0080 E+11	0.52	65	0.86	3
Red	5.309 E+8	1.0536 E+11	0.49	63	0.80	3
Silver	3.999 E+8	7.1225 E+10	0.44	66	0.73	3
Sugar	6.481 E+8	1.1749 E+11	0.56	58	0.88	3
Oak, Red						
Black	5.654 E+8	8.9428 E+10	0.56	80	1.01	4
California Black	4.275 E+8	5.6125 E+11	0.58	106	1.19	6
Cherrybark	7.447 E+8	1.3569 E+11	0.61	78	1.09	4

(Continued)

Table A1 (Continued)

Common Name of Tree Species	Modulus of Rupture S dynes/cm2	Young's Modulus E dynes/cm2	Specific Gravity, SG	Moisture Content, %	Wood Density ρ g/cm3	Strength Class
Oak, Red (Continued)						
Laurel	5.447 E+8	1.0536 E+11	0.56	84	1.03	4
Northern Red	5.723 E+8	1.0232 E+11	0.56	80	1.01	4
Pin	5.723 E+8	1.0005 E+11	0.58	75	1.02	4
Scarlet	7.171 E+8	1.1218 E+11	0.60	65	0.99	4
Southern Red	4.758 E+8	8.6394 E+10	0.52	90	0.99	4
Water	6.137 E+8	1.1749 E+11	0.56	81	1.01	4
Willow	5.102 E+8	9.7771 E+10	0.56	94	1.09	4
Oak, White						
Bur	4.964 E+8	6.6675 E+10	0.58	70	0.99	5
Canyon Live	7.309 E+8	1.0163 E+11	0.84	62	1.36	6
Chestnut	5.516 E+8	1.0384 E+11	0.57	72	0.98	3
Live	8.205 E+8	1.0894 E+11	0.81	50	1.22	6
Overcup	5.516 E+8	8.7153 E+10	0.57	83	1.04	5
Post	5.583 E+8	8.2602 E+10	0.60	69	1.01	5
Swamp Chestnut	5.861 E+8	1.0232 E+11	0.60	76	1.06	4
Swamp White	6.826 E+8	1.2052 E+11	0.64	74	1.13	4
White	5.723 E+8	9.4737 E+10	0.60	68	1.01	4
Pine						
Eastern White	3.379 E+8	7.5018 E+10	0.34	73	0.59	1
Jack	4.137 E+8	8.1085 E+10	0.40	60	0.64	2
Lodgepole	3.792 E+8	8.1844 E+10	0.38	65	0.63	1
Pond	5.102 E+8	9.7082 E+10	0.58	56	0.90	3
Ponderosa	3.448 E+8	7.3501 E+10	0.38	91	0.75	2
Red	3.999 E+8	9.7013 E+10	0.41	92	0.79	2
Sand	5.171 E+8	7.7362 E+10	0.51	36	0.69	3

(Continued)

Table A1 (Concluded)

Common Name of Tree Species	Modulus of Rupture S dynes/cm^2	Young's Modulus E dynes/cm^2	Specific Gravity, SG	Moisture Content, %	Wood Density ρ g/cm3	Strength Class
Pine, Southern Yellow						
Loblolly	5.033 E+8	1.0687 E+11	0.47	81	0.85	2
Longleaf	5.999 E+8	1.2128 E+11	0.54	63	0.88	3
Shortleaf	5.033 E+8	1.0536 E+11	0.46	81	0.83	2
Slash	6.613 E+8	1.1977 E+11	0.56	66	0.93	3
Pine						
Sugar	3.516 E+8	7.1225 E+10	0.35	137	0.83	3
Virginia	5.023 E+8	9.2462 E+10	0.45	88	0.85	3
Western White	3.585 E+8	8.8670 E+10	0.36	54	0.55	1
Redwood, Old Growth	5.171 E+8	8.9428 E+10	0.38	112	0.81	3
Sassafras	4.137 E+8	6.9019 E+10	0.47	67	0.78	3
Spruce						
Black	3.723 E+8	8.0327 E+10	0.38	38	0.52	1
Englemann	3.103 E+8	7.2747 E+10	0.32	80	0.58	1
Red	3.999 E+8	9.0187 E+10	0.38	43	0.54	1
Sitka	3.930 E+8	9.3220 E+10	0.37	42	0.53	1
White	3.861 E+8	8.1085 E+10	0.37	50	0.56	1
Sugarberry	4.551 E+8	6.1366 E+10	0.47	62	0.76	4
Sweet Gum	4.895 E+8	9.0945 E+10	0.46	115	0.99	4
Sycamore, American	4.482 E+8	8.0327 E+10	0.46	83	0.84	3
Tamarack	4.964 E+8	9.3979 E+10	0.49	52	0.74	2
Tupelo						
Black	4.826 E+8	7.8051 E+10	0.46	55	0.71	3
Water	5.033 E+8	7.9568 E+10	0.46	97	0.91	4
Walnut, Black	6.550 E+8	1.0763 E+11	0.51	81	0.92	4
Yellow Poplar	4.137 E+8	9.2462 E+10	0.40	83	0.73	2

(Sheet 5 of 5)

Table A2

Strength Properties of Certain Tree Species Occurring in Tropical and Subtropical Areas

Common Name of Tree Species	Source	Modulus of Rupture S dynes/cm^2	Young's Modulus E* dynes/cm^2	Specific Gravity, SG**	Moisture Content, %	Wood Density ρ g/cm^3	Strength Class
Abura	Africa	5.175 E+8	9.5772 E+10	0.48	101	0.96	4
Acapu; Wacapou	Surinam	1.093 E+9	1.8961 E+11	0.79	48	1.17	5
Aceituno; Marupa; Simarouba	Surinam	4.351 E+8	8.5498 E+10	0.38	65	0.64	2
Achiotillo	Puerto Rico	--	--	0.39	109	0.82	3†
Afrormosia; Kokrodua	Africa	1.022 E+9	1.3397 E+11	0.66	62	1.07	6
Agba; Tola	Africa	4.913 E+8	7.0605 E+10	0.45	56	0.70	3
Aguacatillo††	Puerto Rico	--	--	0.42	88	0.79	3†
Aiele	Africa	3.865 E+8	7.3018 E+10	0.45	94	0.87	3
Alder, Red	United States	4.482 E+8	8.8670 E+10	0.37	98	0.73	2
Alstonia	Africa	3.406 E+8	7.5500 E+10	0.36	123	0.80	2
Angelique; Basra Locus	Surinam	7.867 E+8	1.3955 E+11	0.79	60	1.26	5
Apamate; Mayflower; Roble	Central and South America	7.343 E+8	1.1149 E+11	0.51	62	0.83	4
Apamate; Mayflower; Roble	Venezuela	6.619 E+8	1.1377 E+11	0.45	108	0.94	4
Apamate; Mayflower; Roble	Panama, Honduras, British Honduras	7.426 E+8	1.0411 E+11	0.52	68	0.87	4
Ash, White	United States	6.619 E+8	1.1066 E+11	0.55	42	0.78	3
Bagasse	Brazil	1.000 E+9	1.7306 E+11	0.68	58	1.07	4
Bagtikan; White Seraya	Southeast Asia	5.371 E+8	9.0876 E+10	0.43	70	0.73	3
Balata; Ausubo; Bulletwood††	Surinam, British Guiana, Puerto Rico	1.194 E+9	2.1099 E+11	0.85	48	1.26	5
Balsa; Guano	Puerto Rico	--	--	0.22	97	0.43	1†
Banak; Baboen	Central America	4.275 E+8	1.1149 E+11	0.44	75	0.77	1
Banak; Baboen	Surinam	4.371 E+8	1.3197 E+11	0.42	50	0.63	1
Banak; Baboen	Brazil	3.861 E+8	1.2438 E+11	0.42	94	0.81	1
Baromalli	British Guiana	5.585 E+8	1.2421 E+11	0.50	154	1.27	4
Basswood; Linden	United States	3.448 E+8	7.8879 E+10	0.32	105	0.66	1
Berlinia	Africa	6.878 E+8	1.0708 E+11	0.61	75	1.07	5
Bete; Mansonia	Africa	8.515 E+8	1.1363 E+11	0.57	44	0.82	4
Bilinga; Opepe	Africa	8.974 E+8	1.3955 E+11	0.67	75	1.17	5
Birch, Yellow	United States	5.723 E+8	1.1370 E+11	0.55	67	0.92	3
Bosse; Guarea	Africa	7.074 E+8	1.0467 E+11	0.48	99	0.96	5
Breadfruit; Panapen	Puerto Rico	--	--	0.27	174	0.60	2†
Bustic	United States	8.550 E+8	1.4107 E+11	0.86	44	1.24	5
Cabbage Angelin; Angelin; Moca	Puerto Rico	--	--	0.63	87	1.18	5†
Caimitillo††	Puerto Rico	--	--	0.68	54	1.05	5†
Caimitillo Verde††	Puerto Rico	--	--	0.64	54	0.99	4†
Campomo; Ojoche; Ramon	Guatemala	1.155 E+9	1.5093 E+11	0.72	49	1.07	6
Capa Blanco††	Puerto Rico	--	--	0.66	73	1.14	5†
Caracolillo††	Puerto Rico	--	--	0.77	50	1.16	5†
Casuarina††	Puerto Rico	--	--	0.81	42	1.15	3†
Cativo	Panama	4.098 E+8	7.2053 E+10	0.40	102	0.81	3
Cedar, Spanish; Cedro††	Brazil	4.640 E+8	8.8739 E+10	0.38	84	0.70	2
Cedar, Spanish; Cedro††	Panama	5.178 E+8	9.9357 E+10	0.41	67	0.68	2
Cedar, Spanish; Cedro††	Nicaragua	3.599 E+8	6.5985 E+10	0.34	73	0.59	2
Cedar, Spanish; Cedro††	Guatemala	6.550 E+8	1.1225 E+11	0.43	75	0.75	3
Cedar, Spanish; Cedro††	Puerto Rico	--	--	0.45	83	0.82	3†
Cedar, White; Roble Blanco	Puerto Rico	--	--	0.58	63	0.95	4†
Ceiba; Fuma; Silk-Cotton	Puerto Rico	--	--	0.23	242	0.79	3†
Cottonwood, Eastern	United States	3.654 E+8	7.6534 E+10	0.37	111	0.78	2
Courbaril; Algarrobo; West Indian Locust††	Central and South America	8.929 E+8	1.3804 E+11	0.72	59	1.14	5
Courbaril; Algarrobo; West Indian Locust††	Honduras, Puerto Rico, Surinam, and Panama	8.922 E+8	1.3514 E+11	0.71	61	1.14	5
Courbaril; Algarrobo; West Indian Locust††	British Guiana	8.577 E+8	1.6893 E+11	0.67	65	1.11	4
Crabwood; Andiroba; Cedro Macho	Brazil	7.660 E+8	8.0672 E+10	0.56	72	0.96	6
Crabwood; Andiroba; Cedro Macho	British Guiana	6.826 E+8	1.4866 E+11	0.52	58	0.82	2
Crabwood; Andiroba; Cedro Macho	Surinam	6.536 E+8	1.3804 E+11	0.53	58	0.84	2
Cucubano	Puerto Rico	--	--	0.65	69	1.10	5†
Cupey; Wild Mammee††	Puerto Rico	--	--	0.67	71	1.15	5†
Determa; Wana; Louro Vermelho	South America	5.254 E+8	1.0770 E+11	0.51	89	0.96	3
Determa; Wana; Louro Vermelho	Surinam, British Guiana	5.392 E+8	1.1997 E+11	0.52	83	0.95	3
Dogwood, Flowering	United States	6.068 E+8	8.9497 E+10	0.64	62	1.04	5
Ebony; East Indian	United States	6.995 E+8	1.0391 E+11	0.64	58	1.01	5
Espave	Central and South America	4.668 E+8	8.0396 E+10	0.41	111	0.87	2
Eucalyptus, Beakpod; Eucalipto	Puerto Rico	--	--	0.51	115	1.10	5†
Fiddlewood, White; Higuerillo††	Puerto Rico	--	--	0.62	86	1.15	5†
Fig, Short Leaf; Jaguey Blanco††	Puerto Rico	--	--	0.40	119	0.88	4†
Freijo	Brazil	[illegible] E+8	1.3880 E+11	0.52	53	0.80	3
Genipa; Jagua††	Puerto Rico	--	--	0.66	55	1.02	5†
Gommier; Tabonuco; Candlewood††	Puerto Rico	6.412 E+8	1.1722 E+11	0.53	57	0.83	3
Goncalo Alves	Central and South America	8.550 E+8	1.4410 E+11	0.81	45	1.25	5
Granadillo††	Puerto Rico	--	--	0.61	78	1.09	5†
Greenheart	British Guiana	1.338 E+9	2.2602 E+11	0.83	42	1.18	5

(Continued)

* Parallel to stem.
** Based on weight when oven-dry and volume when green.
† Estimated.
†† Has other common names.

Table A2 (Continued)

Common Name of Tree Species	Source	Modulus of Rupture S dynes/cm^2	Young's Modulus E dynes/cm^2	Specific Gravity, SG	Moisture Content, %	Wood Density ρ g/cm^3	Strength Class
Gronfoeloe	Surinam	5.957 E+8	1.3445 E+11	0.49	151	1.23	4
Guaba††	Puerto Rico	--	--	0.59	70	1.00	4†
Guajon††	Puerto Rico	--	--	0.54	91	1.03	5†
Guama; "Sweetpea"††	Puerto Rico	--	--	0.62	74	1.08	5†
Guanacaste	Africa	3.468 E+8	4.6265 E+10	0.31	226	1.01	5
Guayabota	Puerto Rico	--	--	0.73	58	1.15	5†
Gumbo-Limbo††	United States	2.275 E+8	4.2473 E+10	0.30	99	0.60	1
Gumbo-Limbo††	Guatemala	3.551 E+8	7.1294 E+10	0.38	97	0.75	2
Gumbo-Limbo††	Puerto Rico	--	--	0.29	157	0.75	3†
Imbuia	Brazil	5.309 E+8	8.1913 E+10	0.52	113	1.11	5
Indian Almond; Almendra††	Puerto Rico	--	--	0.59	81	1.07	5†
Iroko; Kambala	Africa	7.009 E+8	9.7357 E+10	0.59	92	1.13	6
Jabillo; Possomwood; Hura††	Central and South America	4.227 E+8	7.6603 E+10	0.38	65	0.63	2
Jabillo; Possomwood; Hura††	Venezuela, Surinam, and Panama	4.351 E+8	8.0672 E+10	0.38	67	0.63	2
Jacana††	Puerto Rico	--	--	0.74	60	1.18	5†
Jamaica Neclandra; Laurel Avispillo	Puerto Rico	--	--	0.47	74	0.82	3†
Jobo; Yellow Mombin††	Guatemala	4.261 E+8	1.1452 E+11	0.39	85	0.72	1
Jobo; Yellow Mombin††	Venezuela	4.413 E+8	8.7980 E+10	0.40	131	0.92	3
Jobo; Yellow Mombin††	Puerto Rico	--	--	0.41	133	0.96	4†
Jusillo††	Puerto Rico	--	--	0.74	65	1.22	5†
Kopie	Brazil, Surinam	7.916 E+8	1.4755 E+11	0.70	66	1.16	4
Kuppier; Keladan	Southeast Asia	8.384 E+8	1.2900 E+11	0.64	64	1.05	5
Kurobai	British Guiana	7.205 E+8	1.1832 E+11	0.53	72	0.91	4
Kwarie	Brazil	4.640 E+8	1.1377 E+11	0.43	119	0.94	2
Kwarie	Surinam	4.171 E+8	1.0274 E+11	0.36	230	1.19	3
Lapacho; Ipe; Bethabara	Panama	1.384 E+9	1.6079 E+11	0.80	41	1.13	6
Lapacho; Ipe; Bethabara	South America	1.576 E+9	2.3208 E+11	0.92	31	1.21	6
Lapacho; Ipe; Bethabara	Surinam, Brazil	1.556 E+9	2.1443 E+11	0.92	31	1.21	6
Laurel; Capa; Capa-Prieto††	Central America	6.095 E+8	9.5565 E+10	0.44	106	0.91	4
Laurel; Capa; Capa-Prieto††	Puerto Rico	--	--	0.57	92	1.09	5†
Laurel Amarillo	Puerto Rico	--	--	0.55	58	0.87	4†
Laurel Geo††	Puerto Rico	--	--	0.45	77	0.80	3†
Laurel Prieto	Puerto Rico	--	--	0.45	65	0.74	3†
Laurel Sabino	Puerto Rico	--	--	0.59	98	1.17	5†
Lovoa; Tigerwood	Africa	5.371 E+8	8.5981 E+10	0.48	61	0.77	3
Mahogany, African; Khaya	Africa	6.550 E+8	1.0708 E+11	0.57	54	0.88	4
Mahogany, Honduras (Forest Grown)††	Mexico	6.136 E+8	1.1101 E+11	0.45	92	0.86	3
Mahogany, Honduras (Forest Grown)††	Nicaragua	5.999 E+8	1.0549 E+11	0.45	110	0.94	4
Mahogany, Honduras (Forest Grown)††	Peru	6.758 E+8	1.0894 E+11	0.51	107	1.06	5
Mahogany, Honduras (Forest Grown)††	Central America	6.371 E+8	9.7849 E+10	0.45	58	0.71	3
Mahogany, Honduras (Forest Grown)††	Brazil	6.178 E+8	9.4462 E+10	0.45	57	0.71	3
Mahogany, Honduras (Plantation Grown)††	Honduras	5.757 E+8	7.1708 E+10	0.42	51	0.63	3
Mahogany, West Indies††	Dominican Republic	6.688 E+8	8.6188 E+10	0.56	95	1.09	6
Mahogany, West Indies††	Cuba	5.688 E+8	8.1154 E+10	0.57	48	0.84	4
Makore	Africa	7.140 E+8	9.6530 E+10	0.54	44	0.78	4
Mamey; Mammee-Apple	Puerto Rico	--	--	0.62	85	1.15	5†
Manbarklak	Surinam	1.180 E+9	1.86[illegible] E+11	0.87	43	1.24	5
Mango	Puerto Rico	--	--	[illegible]	94	0.56	2†
Mango; Mago	Puerto Rico	--	--	0.55	72	0.95	4†
Manni	Surinam, British Guiana	7.709 E+8	1.5996 E+11	0.58	85	1.07	4
Maple, Red	United States	5.309 E+8	1.0596 E+11	0.49	68	0.80	3
Maple, Silver	United States	6.481 E+8	1.1749 E+11	0.56	58	0.88	3
Maricao	Puerto Rico	--	--	0.64	68	1.08	5†
Marish	British Guiana	1.177 E+9	2.2271 E+11	0.88	37	1.21	4
Marish	Brazil, Surinam	9.915 E+8	1.696[illegible] E+11	0.76	50	1.14	5
Martinique Prickly-Ash;	Puerto Rico	--	--	0.46	84	0.85	4†
Espino Rubial††	Puerto Rico	--	--	0.63	52	0.96	4†
Matchwood; Yagrumo Macho††	Puerto Rico	--	--	0.36	81	0.65	2†
Mora	British Guiana, Surinam	8.738 E+8	1.4341 E+11	0.78	60	1.25	4
M[illegible]††	Puerto Rico	--	--	0.80	[illegible]	1.21	5†
Muninga	Africa	[illegible] E+8	8.9290 E+10	0.59	64	0.97	6
Muskwood, America; Guaraguao	Puerto Rico	--	--	0.51	[illegible]	1.14	5†
Nargusta	British Honduras, Panama, and British Guiana	8.964 E+8	1.5376 E+11	0.64	67	1.07	4
Nargusta	Trinidad	9.791 E+8	1.6686 E+11	0.70	51	1.06	4
Negra Lora††	Puerto Rico	--	--	0.70	64	1.15	5†
Nemoca	Puerto Rico	--	--	0.62	62	1.00	4†
Niangon, Whismore	Africa	6.6[illegible] E+8	9.9[illegible] E+10	0.56	47	0.82	4
Nuez Moscada††	Puerto Rico	--	--	0.59	61	0.96	4†
Oak, Roble; Encino	United States	[illegible] E+8	9.4[illegible] E+10	0.6[illegible]	68	1.01	4
Oak; Roble, Encino	Guatemala	7.9[illegible] E+8	1.3[illegible] E+11	0.93	38	1.28	5
Oak, Live	United States	[illegible] E+8	1.1984 E+11	0.81	50	1.22	6
Obeche, Wawa, Samba	Africa	[illegible] E+8	[illegible] E+10	[illegible]	76	0.58	2

(Continued)

* Estimated.

** Has other common names.

(Sheet 2 of 3)

Table A2 (Concluded)

Common Name of Tree Species	Source	Modulus of Rupture S dynes/cm^2	Young's Modulus E dynes/cm^2	Specific Gravity, SG	Moisture Content, %	Wood Density ρ g/cm^3	Strength Class
Okoko; Yellow Sterculia	Africa	7.664 E+8	1.2176 E+11	0.69	60	1.10	5
Okwen	Africa	7.467 E+8	1.0391 E+11	0.60	69	1.01	5
Oxhorn Bucida; Ucar	Puerto Rico	--	--	0.93	37	1.27	6†
Palo De Hueso	Puerto Rico	--	--	0.81	52	1.23	5†
Palo De Matos††	Puerto Rico	--	--	0.50	124	1.12	5†
Pau Amarello	Brazil	9.101 E+8	1.5472 E+11	0.70	59	1.11	5
Pecan	United States	6.757 E+8	1.0301 E+11	0.60	63	0.98	4
Peroba Rosa, Red Peroba	Brazil	7.536 E+8	9.7840 E+10	0.67	30	0.90	5
Petuebi	Brazil	6.619 E+8	1.0770 E+11	0.50	38	0.69	3
Pine, Caribbean	Central America	6.881 E+8	1.2818 E+11	0.68	37	0.93	3
Pine, Caribbean	British Honduras	6.206 E+8	1.2211 E+11	0.65	41	0.92	3
Pine, Slash	United States	6.136 E+8	1.1977 E+11	0.56	66	0.93	3
Pine, Ocote	Honduras	5.495 E+8	1.3197 E+11	0.55	41	0.78	2
Primavera	Honduras	5.316 E+8	7.4328 E+10	0.39	59	0.62	3
Purple Heart; Amaranth	Brazil	1.117 E+9	1.9796 E+11	0.75	64	1.23	5
Purple Heart; Amaranth	British Guiana	1.455 E+9	2.6132 E+11	0.92	42	1.31	5
Purple Heart; Amaranth	Surinam	9.439 E+8	1.5169 E+11	0.67	71	1.15	5
Ramin	Southeast Asia	6.747 E+8	1.1928 E+11	0.59	37	0.81	3
Saman; Raintree	Puerto Rico	--	--	0.44	145	1.08	5†
Santa Maria; Maria	Central America	7.240 E+8	1.1908 E+11	0.55	62	0.89	4
Santa Maria; Maria	British Honduras	7.233 E+8	1.1722 E+11	0.52	62	0.84	3
Santa Maria; Maria	Puerto Rico	--	--	0.55	92	1.06	5†
Sapele	Africa	7.009 E+8	1.1280 E+11	0.60	62	0.97	4
Sipo Utile	Africa	7.467 E+8	1.1280 E+11	0.57	56	0.86	4
Sterculia	British Guiana	6.206 E+8	1.4617 E+11	0.44	94	0.85	2
Suradan	Surinam	7.364 E+8	1.4480 E+11	0.65	83	1.19	4
Swamp Cyrilla; Palo Colorado	Puerto Rico	--	--	0.53	118	1.16	5†
Tabaiba	Puerto Rico	--	--	0.38	96	0.74	3†
Tabebula, White	British Guiana	9.446 E+8	1.7996 E+11	0.55	90	1.05	4
Tatabu	Surinam and Brazil	1.200 E+9	2.0271 E+11	0.78	61	1.26	5
Tauroniro	Surinam	8.081 E+8	1.7031 E+11	0.66	63	1.08	4
Teak††	India	7.571 E+8	1.1452 E+11	0.57	67	0.95	4
Teak††	Burma	7.888 E+8	1.3376 E+11	0.60	52	0.91	4
Teak (Plantation-Grown)††	Honduras	6.854 E+8	9.3082 E+10	0.56	72	0.96	5
Teak††	Puerto Rico	--	--	0.55	83	1.01	4†
Tiama; Edinam	Africa	4.913 E+8	8.1154 E+10	0.50	74	0.87	4
Tonka	Brazil	1.330 E+9	1.8616 E+11	0.91	49	1.36	6
Trumpet-Tree; Yagrumo Hembra	Puerto Rico	--	--	0.29	125	0.65	2†
Wallaba	British Guiana	1.103 E+9	1.9720 E+11	0.78	57	1.22	5
Wamara	British Guiana	1.495 E+9	2.0099 E+11	0.87	38	1.20	6
Yemeri; San Juan	Central America	3.965 E+8	7.9637 E+10	0.35	200	1.05	4
Yemeri; San Juan	Guatemala	4.723 E+8	9.5565 E+10	0.40	148	0.99	3
Yemeri; San Juan	Nicaragua	3.847 E+8	8.0672 E+10	0.33	226	1.08	3

† Estimated.

†† Has other common names.

(Sheet 3 of 3)

Table A3

Wood Strength Classification

If $\frac{S\rho^*}{E} >$	If $\frac{S\rho^*}{E} \leq$	Assign Strength Class
0 (0)	0.2 (0.0032036)	1
0.2 (0.0032036)	0.25 (0.0040045)	2
0.25 (0.0040045)	0.325 (0.0052058)	3
0.325 (0.0052058)	0.4 (0.0064072)	4
0.4 (0.0064072)	0.5 (0.0080090)	5
0.5 (0.0080090)		6

* Values are:

S = modulus of rupture, lb/in.^{2} (dynes/cm^2)

ρ = wood density, lb/ft^3 (g/cm^3)

E = Young's modulus, lb/in.^{2} (dynes/cm^2)

APPENDIX B: PROCEDURES FOR ADDING HELICOPTER DATA FILES

Preparation and Use of General Purpose Data Form

1. The data needed for a complete description of a helicopter are listed in Tables 1-5 (main text). Note that all dimensions are in metres. These data are entered on a standard General Purpose Data Form, as illustrated in Figure B1. The pattern prescribed in Figure B1 must be followed exactly with these points especially noted:

- a. There are no line numbers; the format of each line begins in column 1 of that line. Thus, the "T" in the word "the" of the first line is in column 1.
- b. Lines 1 and 2 contain data composed of some alphabetic and some numeric characters, and they are read with a 24A3 format.
- c. Line 3 contains the only value that is an integer and is read with the fixed point format, I4.
- d Lines 4-19 contain values that are expressed as decimals and are therefore read with a floating point format, F8.3.
- e. Lines 20 and 21 are floating point values read with an F8.0 format.
- f. The definitions to the right of the values are not strictly required; they are included only as a record of what the value represents.
- g. Note that the decimal points in lines 4-19 are positioned in column 5 and those in lines 20 and 21 are in column 8.

2. After the General Purpose Data Form has been prepared, the user has three alternatives from which to choose to construct a new helicopter data file.

- a. Punch the data via the teletype terminal directly into the file space allocated in the computer system.
- b. Punch a paper tape off-line and read that into the allocated file space.
- c. Punch the data into 80-column Hollerith cards and have these read into the allocated file space.

3. The next step is to expand the list of available helicopters in the appropriate programs. Since the statements affected by this expansion are in different locations in each of the three programs (i.e. FTHEL, FTJPRH, and FTJPHL), the procedure must be referenced to

the proper position in each program on an individual basis.

Modifications to Program 1 (FTHEL)

4. After the new helicopter data file has been constructed (i.e. space allocated and filled with the data), three modifications to FTHEL must be made.

a. The program is called into working storage using the appropriate teletype command, on the G-635 system the conventional "OLD" and the file name. For this program, the command to be typed is OLD FTHEL.

b. The list of helicopters is printed by a format statement contained in lines numbered 1350-1380 (Figure B2 and Volume II) in the program listing. The format is labeled 5 FORMAT (Figure B2a) and contains all the helicopters presently included in the data files. Suppose the intent is to add a listing for the CH-37B Mojave aircraft; the format would be revised to look like Figure B2b. By simply typing the revised listing on the teletype, the program listing is automatically altered.

c. Since the program contains a fixed amount of space for helicopter data file names, addition of a new file requires a new space allocation. This is accomplished by altering line 1220 in the program listing (see Volume II). The line at present reads

```
1220 CHARACTER FNAME*8(5)
```

where FNAME is the array containing the names of the helicopter files. The names are 8 characters long (alphanumeric), and the (5) represents the number of available helicopter files. To accommodate additional helicopters, the number in parentheses must equal the total number of helicopters in the files. Thus, if two helicopters are added, line 1220 must be altered to read

```
1220 CHARACTER FNAME*8(7)
```

d. Finally, the file names must be placed in the proper position in the array that contains the available list. The statement that performs this function is given in line 1250 of the program listing, and at present reads

```
1250 DATA FNAME/"/DUH1H;","/DUH1B;","/DOH5A;","/
DCH47A;","/DCH47C;"/
```

The "name" (i.e., DUH1H) is simply a device for labeling a file, and it can be any combination of alphabetic and numeric characters, but the first character must be alphabetic, and it cannot be more than six characters long. In this program, all names in this set of files begin with a "D," followed by the official designation of the aircraft. Thus, the file name for the UH-1H Iroquois is DUH1H. A file created for the CH-37B Mojave would, by this convention, be DCH37B. Note that in line 1250, each file name is preceded by a slash and followed by a semicolon, all inclosed by quotation marks, as

"/DUH1H;"

All of the symbols are essential; the absence of any one of them will result in inability to access that file. Suppose that the intent is to add the CH-37B Mojave to the list. Since line 1250 is full, a new line must be added, making these two lines in the listing read

```
1250 DATA FNAME/"/DUH1H;","/DUH1B;","/DOH6A;","/DCH47A;","/
DCH47C;",1251&"/DCH37B;"/
```

It is essential that the ordering of helicopter names in lines 1250-1251 be identical to the ordering in lines 1350-1380. Thus, for instance, the file name in position 3 in FNAME is DOH6A, and in the format for printing (i.e. lines 1350-1380) position 3 is occupied by the OH-6A Cayuse.

Modifications to Program 2 (FTJPRH)

5. The three modifications to FTHEL must also be made in FTJPRH. The changes are exactly the same; the only difference is the position in the listing where the actual modification is performed. The system command for placing the program in working storage is OLD FTJPRH.

a. The format for printing the list of available helicopters is contained in lines 5810-5840 (Figure B3a and Volume II) and is labeled 5025 FORMAT. If the intent is to add a listing for the CH-37B Mojave aircraft, the format would be revised to look like Figure B3b.

b. The line for allocating space for the new file names in FTJPRH is 5530, which presently reads

```
5530 CHARACTER FNAME*8(5), FILE*8, ISPEC*39
```

FNAME is the array containing the list, and the number in parentheses is the one to be changed to reflect the addition of new files. The line would read as follows if two new files were added.

```
5530 CHARACTER FNAME*8(7), FILE*8, ISPEC*39
```

c. The file names are put in FNAME by the statement in line 5540, which reads

```
5540 DATA FNAME/"/DUH1H;","/DUH1B;","/DOH6A;","/
DCH47A;","/DCH47C;"/
```

This line is full, so if the name of a new file is to be added, a new line must be used. If a file is created for the CH-37B Mojave, DCH37B must be added; the lines would be typed as

```
5540 DATA FNAME/"/DUH1H;","/DUH1B;","/DOH6A;","/
DCH47A;","/DCH47C;",5541&"/DCH37B;"/
```

Modifications to Program 3 (FTJPHL)

6. This program requires the same three modifications as the other two, and they must take place at the proper position in FTJPHL. To get the program in working storage, the command used is OLD FTJPHL.

a. Lines 1140-1170 in the program listing (Figure B4a and Volume II) contain the format for printing the list of available helicopters, and it is labeled 1 FORMAT. Figure B4b is what the lines look like if they are revised to add a listing for the CH-37B Mojave aircraft.

b. FNAME is the array where the names of the files for available helicopters are stored, and in line 1010 space is allocated for these files. The line reads

```
1010 CHARACTER DNAME*8, FNAME*8(5),NHELI*8(7),FILE*8,
CARD*80,BUFFER*1(80)
```

The 5 in parentheses after FNAME tells how many files there are, so when two new files are added, the line is revised to read

```
1010 CHARACTER DNAME*8,FNAME*8(7),NHELI*8(7),FILE*8,
CARD*80,BUFFER*1(80)
```

c. Paragraphs 4d and 5c above discuss how file names are placed in the array FNAME; an identical procedure is followed for FTJPHL, the only difference is the statement in line 1040 which reads

```
1040 DATA FNAME/"/DUH1H;","/DUH1B;","/DOH6A;","/
DCH47A;","/DCH47C;"/
```

When a file named DCH37B is added for the CH-37B Mojave, the statement will read

```
1040 DATA FNAME/"/DUH1H;","/DUH1B;","/DOH6A;","/
DCH47A;","/DCH47C;",1041& "/DCH37B;"/
```

GENERAL PURPOSE DATA FORM

PROGRAM

REQUESTED BY

PREPARED BY J. PARKS

CHECKED BY

DATE 23 MAY 74

PAGE 1 OF 1

```
THE HELICØPTER DESCRIBED BY THESE DATA IS THE
UH-1H IRØQUØIS
    0.      LIFT-ØFF CØDE (0 = NØT VERTICAL, 1 = VERTICAL)
    0.39    GRØUND CLEARANCE ØF HULL (M)
   66.0     APPRØACH ANGLE (DEG)
   22.0     DEPARTURE ANGLE - MINIMUM VALUE (DEG)
   66.0     DEPARTURE ANGLE - MEDIAN VALUE (DEG)
   90.0     DEPARTURE ANGLE - MAXIMUM VALUE (DEG)
   10.5     RADIUS ØF TØUCH ZØNE - MINIMUM (M)
   15.0     RADIUS ØF TØUCH ZØNE - MAXIMUM (M)
   15.0     MAXIMUM SAFE GRØUND SLØPE FØR AN FTZ (PERCENT)
   23.0     MAXIMUM SAFE GRØUND SLØPE FØR AN STZ (PERCENT)
   46.0     MAXIMUM SAFE GRØUND SLØPE FØR AN NTZ (PERCENT)
   18.0     CØNE INDEX FØR AN FTZ, MAXIMUM LØAD (PSI)
    2.85    MAXIMUM WIDTH ØF CRØSS-SECTIØN ØF HULL (M)
   13.66    LENGTH ØF HULL (M)
   14.71    DIAMETER ØF RØTØR (M)
    2.37    GRØUND CLEARANCE ØF RØTØR BLADES - STATIC (M)
    0.0     GRØUND CLEARANCE ØF RØTØR BLADES - IDLING (M)
 7800.      WEIGHT - EMPTY (LBS)
 9500.      WEIGHT - MAXIMUM LØAD (LBS)
```

WES FORM NO 1233
SEPTEMBER 1962

Figure B1. Helicopter file information recorded on a data form for punching into computer cards

```
1350 5 FORMAT (1H0,2X,45HTHE FOLLOWING HELICOPTER FILES ARE AVAILABLE:/
1360&5X,18H1. UH-1H, IROQUOIS/5X,18H2. UH-1B, IROQUOIS/5X,16H3. OH-6A,
1370&CAYUSE/5X,18H4. CH-47A, CHINOOK/5X,18H5. CH-47C, CHINOOK//2X,40HSE
1380&LECT A HELICOPTER AND TYPE ITS NUMBER.//)
```

a. Lines 1350-1380 from the program listing in Volume II

```
1350 5 FORMAT (1H0,2X,45HTHE FOLLOWING HELICOPTER FILES ARE AVAILABLE:/
1360&5X,18H1. UH-1H, IROQUOIS/5X,18H2. UH-1B, IROQUOIS/5X,16H3. OH-6A,
1370&CAYUSE/5X,18H4. CH-47A, CHINOOK/5X,18H5. CH-47C, CHINOOK/5X,17H6.
1380&CH-37B, MOJAVE//2X,40HSELECT A HELICOPTER AND TYPE ITS NUMBER.//)
```

b. Lines 1350-1380 modified to include CH-37B Mojave in the available list

Figure B2. Modification of program lines in FTHEL to accommodate an additional helicopter

```
5810 5025 FORMAT (//"THE FOLLOWING HELICOPTER FILES ARE AVAILABLE:"/5X,
5820&18H1. UH-1H, IROQUOIS/5X,18H2. UH-1B, IROQUOIS/5X,16H3. OH-6A, CAYU
5830&SE/5X,18H4. CH-47A, CHINOOK/5X,18H5. CH-47C, CHINOOK//40HSELECT A H
5840&ELICOPTER AND TYPE ITS NUMBER.)
```

a. Lines 5810-5840 from the program listing in Volume II

```
5810 5025 FORMAT (//"THE FOLLOWING HELICOPTER FILES ARE AVAILABLE:"/5X,
5820&18H1. UH-1H, IROQUOIS/5X,18H2. UH-1B, IROQUOIS/5X,16H3. OH-6A, CAYU
5830&SE/5X,18H4. CH-47A, CHINOOK/5X,18H5. CH-47C, CHINOOK/5X,17H6. CH-37
5840&B, MOJAVE//40HSELECT A HELICOPTER AND TYPE ITS NUMBER.)
```

b. Lines 5810-5840 modified to include CH-37B Mojave in the available list

Figure B3. Modification of program lines in FTJPRH to accommodate an additional helicopter

```
1140 1 FORMAT (1H0,45HTHE FOLLOWING HELICOPTER FILES ARE AVAILABLE:/5X,
1150&18H1. UH-1H, IROQUOIS/5X,18H2. UH-1B, IROQUOIS/5X,16H3. OH-6A, CAYU
1160&SE/5X,18H4. CH-47A, CHINOOK/5X,18H5. CH-47C, CHINOOK//1X,
1170&40HSELECT A HELICOPTER AND TYPE ITS NUMBER./)
```

a. Lines 1140-1170 from the program listing in Volume II

```
1140 1 FORMAT (1H0,45HTHE FOLLOWING HELICOPTER FILES ARE AVAILABLE:/5X,
1150&18H1. UH-1H, IROQUOIS/5X,18H2. UH-1B, IROQUOIS/5X,16H3. OH-6A, CAYU
1160&SE/5X,18H4. CH-47A, CHINOOK/5X,18H5. CH-47C, CHINOOK/5X,17H6. CH-37
1170&B, MOJAVE//1X,40HSELECT A HELICOPTER AND TYPE ITS NUMBER./)
```

b. Lines 1140-1170 modified to include CH-37B Mojave in the available list

Figure B4. Modification of program lines in FTJPHL to accommodate an additional helicopter

APPENDIX C: EXAMPLE RUNS OF COMPUTER PROGRAMS
(FTHEL, FTJPRH, AND FTJPHL)

PROGRAM FTHEL

Data Input Form for FTHEL

A. Microrelief Feature Data

	Height Class I	Height Class II	Height Class III	Height Class IV	Height Class V	Height Class VI
Height of upper limit of each class	0	.37	0	2.8	3.5	5.0
Average diameter of microrelief features in each class	0	20	0	33	38	40
Number of features in each class	0	20	0	15	20	18

B. Additional Terrain Descriptors

100 Cone index, psi

80 Radius of largest sample cell of microrelief features that are homogeneously distributed, m

50 Ground slope, deg

+ + + + + + +

THE FOLLOWING HELICOPTER FILES ARE AVAILABLE:

1. UH-1H, IROQUOIS
2. UH-1B, IROQUOIS
3. OH-6A, CAYUSE
4. CH-47A, CHINOOK
5. CH-47C, CHINOOK

SELECT A HELICOPTER AND TYPE ITS NUMBER.

=5

SELECT 17.25 OR 26.90 METERS AS TOUCH ZONE RADIUS.

=26

INPUT THE MAXIMUM HEIGHT (M) THAT OCCURS IN EACH OF THE SIX MICRORELIEF HEIGHT CLASSES (BEGIN WITH THE LARGEST HEIGHT CLASS).

=5,3.5,2.8,0,.37,0

INPUT THE AVERAGE OBSTACLE DIAMETER (CM) FOR EACH MICRORELIEF HEIGHT CLASS (BEGIN WITH THE LARGEST HEIGHT CLASS).

=40,38,33,0,20,0

INPUT THE NUMBER OF MICRORELIEF FEATURES IN EACH HEIGHT CLASS INCLUDED IN THE SAMPLE CELL AREA (BEGIN WITH THE LARGEST CLASS).

=18,20,15,0,20,0

INPUT THREE VALUES: THE CONE INDEX (SOIL STRENGTH IN PSI), LARGEST SAMPLE CELL RADIUS (M), AND GROUND SLOPE (DEG).

=100,80,50

\+ + + + + + +

LANDING ZONES WILL BE CLASSIFIED AS:
    FULL TOUCH (FTZ)
    SKID TOUCH (STZ)
    NON-TOUCH (NTZ)
    NO LANDING (NLZ)

THE PREDICTIONS WHICH ARE MADE IMPLY THE FOLLOWING:
    IF FTZ PREDICTED, FTZ, STZ, AND NTZ ARE POSSIBLE.
    IF STZ PREDICTED, STZ AND NTZ ARE POSSIBLE.
    IF NTZ PREDICTED, ONLY NTZ IS POSSIBLE.
    IF NLZ PREDICTED, THE SITE IS UNACCEPTABLE AS A
        LANDING ZONE OF ANY KIND.

\+ + + + + + +

WOULD YOU LIKE TO SEE THE DEFINITIONS OF THE LANDING ZONE CLASSIFICATIONS ? (TYPE YES OR NO)

=NO

\+ + + + + + +

THE SITE CONDITIONS SPECIFIED WERE EVALUATED FOR THE CH-47C CHINOOK, AND THE RESULTS ARE AS FOLLOWS:

1. THE LANDING ZONE CLASSIFICATION IS NLZ.
2. FOR THE NLZ CLASSIFICATION, NO DEPARTURE ANGLE IS COMPUTED.

Data Input Form for FTHEL

A. Microrelief Feature Data

	Height Class I	Height Class II	Height Class III	Height Class IV	Height Class V	Height Class VI
Height of upper limit of each class	.1	.31	1.2	2.5	3.4	0
Average diameter of microrelief features in each class	8	15	33	36	40	0
Number of features in each class	20	22	20	18	15	0

B. Additional Terrain Descriptors

75 Cone index, psi

100 Radius of largest sample cell of microrelief features that are homogeneously distributed, m

3 Ground slope, deg

+ + + + + + +

THE FOLLOWING HELICOPTER FILES ARE AVAILABLE:
1. UH-1H, IROQUOIS
2. UH-1B, IROQUOIS
3. OH-6A, CAYUSE
4. CH-47A, CHINOOK
5. CH-47C, CHINOOK

SELECT A HELICOPTER AND TYPE ITS NUMBER.

=1

SELECT 10.50 OR 15.00 METERS AS TOUCH ZONE RADIUS.

=15

INPUT THE MAXIMUM HEIGHT (M) THAT OCCURS IN EACH OF THE SIX MICRORELIEF HEIGHT CLASSES (BEGIN WITH THE LARGEST HEIGHT CLASS).

=0,3.4,2.5,1.2,.31,.1

INPUT THE AVERAGE OBSTACLE DIAMETER (CM) FOR EACH MICRORELIEF HEIGHT CLASS (BEGIN WITH THE LARGEST HEIGHT CLASS).

=0,40,36,33,15,8

INPUT THE NUMBER OF MICRORELIEF FEATURES IN EACH HEIGHT CLASS INCLUDED IN THE SAMPLE CELL AREA (BEGIN WITH THE LARGEST CLASS).

=0,15,18,20,22,20

INPUT THREE VALUES: THE CONE INDEX (SOIL STRENGTH IN PSI), LARGEST SAMPLE CELL RADIUS (M), AND GROUND SLOPE (DEG).

=75,100,3

\+ + + + + + +

LANDING ZONES WILL BE CLASSIFIED AS:
    FULL TOUCH (FTZ)
    SKID TOUCH (STZ)
    NON-TOUCH (NTZ)
    NO LANDING (NLZ)

THE PREDICTIONS WHICH ARE MADE IMPLY THE FOLLOWING:
    IF FTZ PREDICTED, FTZ, STZ, AND NTZ ARE POSSIBLE.
    IF STZ PREDICTED, STZ AND NTZ ARE POSSIBLE.
    IF NTZ PREDICTED, ONLY NTZ IS POSSIBLE.
    IF NLZ PREDICTED, THE SITE IS UNACCEPTABLE AS A
        LANDING ZONE OF ANY KIND.

\+ + + + + + +

WOULD YOU LIKE TO SEE THE DEFINITIONS OF THE LANDING ZONE CLASSIFICATIONS ? (TYPE YES OR NO)

=NO

\+ + + + + + +

THE SITE CONDITIONS SPECIFIED WERE EVALUATED FOR THE UH-1H IROQUOIS, AND THE RESULTS ARE AS FOLLOWS:
    1. THE LANDING ZONE CLASSIFICATION IS FTZ.
    2. THE MINIMUM DEPARTURE ANGLE IS 32.7 DEG.

Data Input Form for FTHEL

A. Microrelief Feature Data

	Height Class I	Height Class II	Height Class III	Height Class IV	Height Class V	Height Class VI
Height of upper limit of each class	.3	0	1.8	0	0	6
Average diameter of microrelief features in each class	10	0	30	0	0	100
Number of features in each class	20	0	22	0	0	10

B. Additional Terrain Descriptors

45 Cone index, psi

100 Radius of largest sample cell of microrelief features that are homogeneously distributed, m

5 Ground slope, deg

+ + + + + + +

THE FOLLOWING HELICOPTER FILES ARE AVAILABLE:

1. UH-1H, IROQUOIS
2. UH-1B, IROQUOIS
3. OH-6A, CAYUSE
4. CH-47A, CHINOOK
5. CH-47C, CHINOOK

SELECT A HELICOPTER AND TYPE ITS NUMBER.

=5

SELECT 17.25 OR 26.00 METERS AS TOUCH ZONE RADIUS.

=17.25

INPUT THE MAXIMUM HEIGHT (M) THAT OCCURS IN EACH OF THE SIX MICRORELIEF HEIGHT CLASSES (BEGIN WITH THE LARGEST HEIGHT CLASS).

=6,0,0,1.8,0,.3

INPUT THE AVERAGE OBSTACLE DIAMETER (CM) FOR EACH MICRORELIEF HEIGHT CLASS (BEGIN WITH THE LARGEST HEIGHT CLASS).

=100,0,0,30,0,10

INPUT THE NUMBER OF MICRORELIEF FEATURES IN EACH HEIGHT CLASS INCLUDED IN THE SAMPLE CELL AREA (BEGIN WITH THE LARGEST CLASS).

=10,0,0,22,0,20

INPUT THREE VALUES: THE CONE INDEX (SOIL STRENGTH IN PSI), LARGEST SAMPLE CELL RADIUS (M), AND GROUND SLOPE (DEG).

=45,100,5

+ + + + + + +

LANDING ZONES WILL BE CLASSIFIED AS:
    FULL TOUCH (FTZ)
    SKID TOUCH (STZ)
    NON-TOUCH (NTZ)
    NO LANDING (NLZ)

THE PREDICTIONS WHICH ARE MADE IMPLY THE FOLLOWING:
    IF FTZ PREDICTED, FTZ, STZ, AND NTZ ARE POSSIBLE.
    IF STZ PREDICTED, STZ AND NTZ ARE POSSIBLE.
    IF NTZ PREDICTED, ONLY NTZ IS POSSIBLE.
    IF NLZ PREDICTED, THE SITE IS UNACCEPTABLE AS A
        LANDING ZONE OF ANY KIND.

+ + + + + + +

WOULD YOU LIKE TO SEE THE DEFINITIONS OF THE LANDING ZONE CLASSIFICATIONS ? (TYPE YES OR NO)

=NO

+ + + + + + +

THE SITE CONDITIONS SPECIFIED WERE EVALUATED FOR THE CH-47C CHINOOK, AND THE RESULTS ARE AS FOLLOWS:
1. THE LANDING ZONE CLASSIFICATION IS STZ.
2. THE MINIMUM DEPARTURE ANGLE IS 31.3 DEG.

Data Input Form for FTHEL

A. Microrelief Feature Data

	Height Class I	Height Class II	Height Class III	Height Class IV	Height Class V	Height Class VI
Height of upper limit of each class	0	.32	1.5	0	3.3	4.2
Average diameter of microrelief features in each class	0	18	25	0	36	50
Number of features in each class	0	20	20	0	16	15

B. Additional Terrain Descriptors

50 Cone index, psi

100 Radius of largest sample cell of microrelief features that are homogeneously distributed, m

3 Ground slope, deg

\+ + + + + + +

```
 THE FOLLOWING HELICOPTER FILES ARE AVAILABLE:
   1. UH-1H, IROQUOIS
   2. UH-1B, IROQUOIS
   3. OH-6A, CAYUSE
   4. CH-47A, CHINOOK
   5. CH-47C, CHINOOK

 SELECT A HELICOPTER AND TYPE ITS NUMBER.

=4

SELECT   21.00 OR   26.00 METERS AS TOUCH ZONE RADIUS.

=21

 INPUT THE MAXIMUM HEIGHT (M) THAT OCCURS IN EACH OF THE SIX
 MICRORELIEF HEIGHT CLASSES  (BEGIN WITH THE LARGEST HEIGHT
 CLASS).

=4.2,3.3,0,1.5,.32,0

 INPUT THE AVERAGE OBSTACLE DIAMETER (CM) FOR EACH MICRORELIEF
 HEIGHT CLASS  (BEGIN WITH THE LARGEST HEIGHT CLASS).

=50,36,0,25,18,0

 INPUT THE NUMBER OF MICRORELIEF FEATURES IN EACH HEIGHT CLASS
 INCLUDED IN THE SAMPLE CELL AREA  (BEGIN WITH THE LARGEST
 CLASS).

=15,16,0,20,20,0

 INPUT THREE VALUES:  THE CONE INDEX (SOIL STRENGTH IN PSI),
 LARGEST SAMPLE CELL RADIUS (M), AND GROUND SLOPE (DEG).

=50,100,3
```

\+ \+ \+ \+ \+ \+ \+

LANDING ZONES WILL BE CLASSIFIED AS:

FULL TOUCH (FTZ)
SKID TOUCH (STZ)
NON-TOUCH (NTZ)
NO LANDING (NLZ)

THE PREDICTIONS WHICH ARE MADE IMPLY THE FOLLOWING:

IF FTZ PREDICTED, FTZ, STZ, AND NTZ ARE POSSIBLE.
IF STZ PREDICTED, STZ AND NTZ ARE POSSIBLE.
IF NTZ PREDICTED, ONLY NTZ IS POSSIBLE.
IF NLZ PREDICTED, THE SITE IS UNACCEPTABLE AS A LANDING ZONE OF ANY KIND.

\+ \+ \+ \+ \+ \+ \+

WOULD YOU LIKE TO SEE THE DEFINITIONS OF THE LANDING ZONE CLASSIFICATIONS ? (TYPE YES OR NO)

=NO

\+ \+ \+ \+ \+ \+ \+

THE SITE CONDITIONS SPECIFIED WERE EVALUATED FOR THE CH-47A CHINOOK, AND THE RESULTS ARE AS FOLLOWS:

1. THE LANDING ZONE CLASSIFICATION IS STZ.
2. THE MINIMUM DEPARTURE ANGLE IS 59.7 DEG.

Data Input Form for FTHEL

A. Microrelief Feature Data

	Height Class I	Height Class II	Height Class III	Height Class IV	Height Class V	Height Class VI
Height of upper limit of each class	.1	.31	1.2	0	0	0
Average diameter of microrelief features in each class	8	15	33	0	0	0
Number of features in each class	22	20	20	0	0	0

B. Additional Terrain Descriptors

75 Cone index, psi

100 Radius of largest sample cell of microrelief features that are homogeneously distributed, m

2 Ground slope, deg

\+ + + + + + +

THE FOLLOWING HELICOPTER FILES ARE AVAILABLE:
1. UH-1H, IROQUOIS
2. UH-1B, IROQUOIS
3. OH-6A, CAYUSE
4. CH-47A, CHINOOK
5. CH-47C, CHINOOK

SELECT A HELICOPTER AND TYPE ITS NUMBER.

=1

SELECT 10.50 OR 15.00 METERS AS TOUCH ZONE RADIUS.

=15

INPUT THE MAXIMUM HEIGHT (M) THAT OCCURS IN EACH OF THE SIX MICRORELIEF HEIGHT CLASSES (BEGIN WITH THE LARGEST HEIGHT CLASS).

=0,0,0,1.2,.31,.1

INPUT THE AVERAGE OBSTACLE DIAMETER (CM) FOR EACH MICRORELIEF HEIGHT CLASS (BEGIN WITH THE LARGEST HEIGHT CLASS).

=0,0,0,33,15,8

INPUT THE NUMBER OF MICRORELIEF FEATURES IN EACH HEIGHT CLASS INCLUDED IN THE SAMPLE CELL AREA (BEGIN WITH THE LARGEST CLASS).

=0,0,0,20,20,22

INPUT THREE VALUES: THE CONE INDEX (SOIL STRENGTH IN PSI), LARGEST SAMPLE CELL RADIUS (M), AND GROUND SLOPE (DEG).

=75,100,2

+ + + + + + +

LANDING ZONES WILL BE CLASSIFIED AS:

```
     FULL TOUCH  (FTZ)
     SKID TOUCH  (STZ)
     NON-TOUCH   (NTZ)
     NO LANDING  (NLZ)
```

THE PREDICTIONS WHICH ARE MADE IMPLY THE FOLLOWING:

```
     IF FTZ PREDICTED, FTZ, STZ, AND NTZ ARE POSSIBLE.
     IF STZ PREDICTED, STZ AND NTZ ARE POSSIBLE.
     IF NTZ PREDICTED, ONLY NTZ IS POSSIBLE.
     IF NLZ PREDICTED, THE SITE IS UNACCEPTABLE AS A
          LANDING ZONE OF ANY KIND.
```

+ + + + + + +

WOULD YOU LIKE TO SEE THE DEFINITIONS OF THE LANDING ZONE CLASSIFICATIONS ? (TYPE YES OR NO)

=NO

+ + + + + + +

THE SITE CONDITIONS SPECIFIED WERE EVALUATED FOR THE UH-1H IROQUOIS, AND THE RESULTS ARE AS FOLLOWS:

1. THE LANDING ZONE CLASSIFICATION IS FTZ.
2. THE MINIMUM DEPARTURE ANGLE IS 6.7 DEG.

PROGRAM FTJPRH

Vegetation Input Data Format 1

Site SS-01

Weapon yield 6.63 Output file name RHF4

	Item	Value
1.	Common name (not to exceed 39 characters)	Sweetgum
2.	Tree identification number (1-999)	1
3.	Modulus of rupture, dynes/cm^2*	4.895E+8
4.	Young's modulus, dynes/cm^2*	9.0945E+10
5.	Wood density (green), g/cm^3	0.99
	OR	
	Specific gravity and	
	Moisture content, %	
6.	Stem diameter, cm, measured at height of 1 m above stem base	16
7.	Maximum tree height, m to nearest tenth	8.0
8.	Tree positions (select one method from the following)	
	a. Calculate at 1-m intervals from GZ	YES X NO
	b. Several locations of this tree at discrete distances from GZ, m; enter distances in ascending order (maximum of 115 positions)	No. locations: Distances:
	c. Locations of this tree defined by XY-coordinates; enter coordinates of GZ first, then follow with X and Y for each tree position (maximum of 115 positions)	No. locations: Coordinates:

* These values are quite large, and it is much easier to enter the value as a number with an exponent (as a power of 10). In computer language, E represents the term, power of 10, e.g.

Modulus of rupture = 524400000. = 5.244E+8

Vegetation Input Data Format 1

Site SS-01

Weapon yield 6.63 Output file name RHF4

Item	Value
1. Common name (not to exceed 39 characters)	Shagbark Hickory
2. Tree identification number (1-999)	2
3. Modulus of rupture, dynes/cm^2*	7.584E+8
4. Young's modulus, dynes/cm^2*	1.1901E+11
5. Wood density (green), g/cm^3	
OR	
Specific gravity and	0.64
Moisture content, %	60
6. Stem diameter, cm, measured at height of 1 m above stem base	22
7. Maximum tree height, m to nearest tenth	10.5
8. Tree positions (select one method from the following)	
a. Calculate at 1-m intervals from GZ	YES ____ NO X
b. Several locations of this tree at discrete distances from GZ, m; enter distances in ascending order (maximum of 115 positions)	No. locations: 17 Distances: 3, 6, 9, 12, 15, 18, 21, 24, 27, 30, 33, 36, 39, 42, 45, 48, 51,
c. Locations of this tree defined by XY-coordinates; enter coordinates of GZ first, then follow with X and Y for each tree position (maximum of 115 positions)	No. locations: ____ Coordinates:

* These values are quite large, and it is much easier to enter the value as a number with an exponent (as a power of 10). In computer language, E represents the term, power of 10, e.g.

Modulus of rupture = 524400000. = 5.244E+8

```
* * * * * * * * * * * * * * * * * * * * * * * * *

IS YOUR KNOWLEDGE OF THIS PROGRAM AND ITS OPERATION
SUFFICIENT TO ELIMINATE TYPING THE GENERAL EXPLANATIONS
AND INSTRUCTIONS AND BEGIN IMMEDIATELY WITH THE INPUT
OF DATA ?  (TYPE YES OR NO)
=NO


************************************************************


************************************************************
GIVEN A WEAPON YIELD (METRIC TONS, TNT) AND TREE
DESCRIPTIONS, THIS PROGRAM CALCULATES A VEGETATION
PROFILE (TREE REMNANT HEIGHT VERSUS DISTANCE FROM
GROUND ZERO) AND STORES IT IN A FILE FOR LATER USE.
AN OPTION IS PROVIDED TO GRAPHICALLY COMPARE THE
VEGETATION PROFILE WITH A PROFILE OF THE FLIGHT PATH
OF A HELICOPTER.  THE RELIABILITY OF THE OUTPUT IS
DEPENDENT ON THE DETAIL AND ACCURACY OF THE TREE
DESCRIPTIONS.

TREE DATA ARE INPUT USING ONE OF THREE FORMATS.  THE FIRST
IS FOR THE MOST SPECIFIC DATA AND THE SECOND IS FOR THE
MOST GENERAL DATA.  FORMAT 3 ALLOWS ENTRY OF TREE DATA ON
THE BASIS OF SIX WOOD STRENGTH CLASSES AND NINE STEM
DIAMETER CLASSES (54 COMBINATIONS).  USE OF FORMAT 3 IS
NECESSARY WHENEVER PREDICTIONS ARE NEEDED ON THE PROBABLE
NUMBER OF TREES REQUIRING REMOVAL AFTER A BOMB EXPLOSION.

**********
FORMAT 1: YOU ARE REQUESTED TO FURNISH DATA FOR ONE TREE
SPECIES.  UPON REQUEST, TYPE:

   COMMON NAME *

   TREE POSITIONS INDICATED BY ONE OF THE FOLLOWING:
     1. RADIAL DISTANCES FROM GROUND ZERO
     2. XY-COORDINATES (ALSO INCLUDES COORDINATES OF
        GROUND ZERO)
     3. AT 1-METER INTERVALS FROM GROUND ZERO

   STEM DIAMETER
```

TREE HEIGHT

WOOD DENSITY, OR SPECIFIC GRAVITY AND MOISTURE CONTENT OF WOOD *

RUPTURE MODULUS *

YOUNG'S MODULUS PARALLEL TO STEM (MODULUS OF ELASTICITY IN COMPRESSION IS EQUAL TO MODULUS OF ELASTICITY + 10%) *

* SUGGESTED REFERENCE: TABLE 12, WOOD HANDBOOK NO. 72 USDA

NOTE: FOR CONVERTING UNITS IN TABLE 12 TO METRIC UNITS USE THE CONVERSION FACTOR 1 PSI = 68950 DYNES/SQ CM

****

FORMAT 2: YOU ARE REQUESTED TO LOOK THROUGH A LIST OF COMMON NAMES FOR TREE SPECIES AND CLASSIFY THE TREES IN THE PROPOSED LANDING SITE INTO SIX WOOD STRENGTH CLASSES. UPON REQUEST, TYPE:

MAXIMUM WOOD STRENGTH CLASS IN THE SITE

MAXIMUM STEM DIAMETER IN THAT STRENGTH CLASS

MAXIMUM TREE HEIGHT IN THAT STRENGTH CLASS

****

FORMAT 3: YOU ARE REQUESTED TO EXAMINE THE LIST OF COMMON NAMES FOR TREE SPECIES AND CLASSIFY THE TREES IN THE PROPOSED LANDING SITE INTO SIX STRENGTH CLASSES AND THEN INTO NINE STEM DIAMETER CLASSES. UPON REQUEST, TYPE:

MAXIMUM STEM DIAMETER IN EACH DIAMETER CLASS FOR EACH WOOD STRENGTH CLASS

MAXIMUM TREE HEIGHT IN EACH DIAMETER CLASS FOR EACH WOOD STRENGTH CLASS

****

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**************************************************************
YOU WILL NOW ENGAGE IN A CONVERSATION WITH THE COMPUTER
BY ANSWERING A SERIES OF QUESTIONS.  TWO INSTRUCTIONS TO
REMEMBER ARE:

 1. TO ANSWER YES OR NO QUESTIONS, TYPE YES OR NO.
 2. TO ANSWER QUESTIONS WITH MULTIPLE ANSWERS, TYPE
    EACH VALUE IN THE ORDER ASKED FOR AND SEPARATE
    THE VALUES WITH COMMAS.
**************************************************************


WHAT IS THE WEAPON YIELD IN METRIC TONS, TNT ?
   EXAMPLE: 10,000 LB GENERAL PURPOSE BOMB HAS A YIELD
            OF 3.6 METRIC TONS, TNT
=6.63

WHICH INPUT FORMAT DO YOU WANT TO USE ?
 (TYPE 1, 2, OR 3)
=1

WHAT IS THE NAME OF THE OUTPUT FILE WHICH IS TO CONTAIN
THE DISTANCES AND REMNANT HEIGHTS ?
=RHF4


**************************************************************

I. ENTER THE COMMON NAME OF THIS TREE SPECIES. (NAME
   NOT TO EXCEED 39 CHARACTERS)
=SWEETGUM

II. FOR THE TREE SPECIES, ENTER:
   1. THREE IDENTIFICATION NUMBER (NOT TO EXCEED 999)
   2. MODULUS OF RUPTURE (DYNES/CM SQ)
   3. YOUNG'S MODULUS (DYNES/CM SQ)

     EXAMPLE: 1,6.13E+8,1.06E+11

=1,4.895E+8,9.0945E+10

III. IF WOOD DENSITY IS AVAILABLE, ENTER:
       1,DENSITY VALUE,1
        EXAMPLE: 1,1.01,1
```

```
     IF NOT AVAILABLE, ENTER:
       2,SPECIFIC GRAVITY, MOISTURE CONTENT (PERCENT)
         EXAMPLE: 2,0.56,80

=1,0.99,1

IV. ENTER: TREE STEM DIAMETER (CM) AND TREE HEIGHT
    (M, TO NEAREST TENTH).
=16,8.0

DO YOU WANT TREE REMNANT HEIGHTS CALCULATED AT 1-METER
INTERVALS FROM GROUND ZERO ?
=YES

DO YOU WANT TO COMPARE THE TREE REMNANT HEIGHT PROFILE AND
THE LANDING ZONE GEOMETRY REQUIRED FOR A HELICOPTER ?
=YES


THE FOLLOWING HELICOPTER FILES ARE AVAILABLE:
    1. UH-1H, IROQUOIS
    2. UH-1B, IROQUOIS
    3. OH-6A, CAYUSE
    4. CH-47A, CHINOOK
    5. CH-47C, CHINOOK

SELECT A HELICOPTER AND TYPE ITS NUMBER.
=2

SELECT 10.0 OR 15.0 METERS AS TOUCH ZONE RADIUS.
=10

SELECT A DEPARTURE ANGLE WITHIN THE LIMITS OF  22. AND  75. DEGREES.
=35


* * * * * * * * * * * * * * * * * * * * * * * * *

     HELICOPTER                          UH-1B
     DEPARTURE ANGLE (DEG)                 35.0
     RADIUS OF TOUCH ZONE (M)              10.0
     WEAPON YIELD (METRIC TONS, TNT)        6.6
```

TREE IDENTIFICATION NUMBER 1
COMMON SPECIES NAME: SWEETGUM
MODULUS OF RUPTURE (DYNES/CM SQ) 0.48950000E 09
YOUNG'S MODULUS (DYNES/CM SQ) 0.90945000E 11
WOOD DENSITY (GRAMS/CM CUBED) 0.99

MAXIMUM TREE DIAMETER (CM) 16.
MAXIMUM TREE HEIGHT (M) 8.

****

DISTANCE FROM GROUND ZERO (M)	TREE REMNANT HEIGHT (M)	HEIGHT OF GLIDE PATH (M)
3.00	0.38	0.30
4.00	0.46	0.30
5.00	0.54	0.30
6.00	0.60	0.30
7.00	0.65	0.30
8.00	0.70	0.30
9.00	0.74	0.30
10.00	0.79	0.30
11.00	0.85	1.00
12.00	0.90	1.70
13.00	0.96	2.40
14.00	1.03	3.10
15.00	1.09	3.80
16.00	1.14	4.50
17.00	1.19	5.20
18.00	1.25	5.90
19.00	1.33	6.60
20.00	1.48	7.30
21.00	1.74	8.00
22.00	2.17	8.70
23.00	2.84	9.40
24.00	3.73	10.10
25.00	4.81	10.80
26.00	5.96	11.50
27.00	7.09	12.20
28.00	8.00 *	12.90

* MAXIMUM TREE HEIGHT

```
* * * * * * * * * * * * * * * * * * * * * * * * *

DO YOU WANT TO COMPARE DATA FOR:
 1. REMNANT PROFILE AND ANOTHER DEPARTURE ANGLE (DA) ?
 2. REMNANT PROFILE AND ANOTHER TOUCH ZONE RADIUS (RTZ) ?
 3. REMNANT PROFILE AND ANOTHER DA AND RTZ ?
 4. REMNANT PROFILE AND ANOTHER HELICOPTER ?
 5. NO MORE ?

SELECT ONE AND TYPE ITS NUMBER.
=5

DO YOU HAVE ANOTHER TREE SPECIES ?
=YES


**************************************************************

I. ENTER THE COMMON NAME OF THIS TREE SPECIES. (NAME
   NOT TO EXCEED 39 CHARACTERS)
=SHAGBARK HICKORY

II. FOR THE TREE SPECIES, ENTER:
   1. TREE IDENTIFICATION NUMBER (NOT TO EXCEED 999)
   2. MODULUS OF RUPTURE (DYNES/CM SQ)
   3. YOUNG'S MODULUS (DYNES/CM SQ)

     EXAMPLE: 1,6.13E+8,1.06E+11

=2,7.584E+8,1.1901E+11

III. IF WOOD DENSITY IS AVAILABLE, ENTER:
       1,DENSITY VALUE,1
        EXAMPLE: 1,1.01,1

     IF NOT AVAILABLE, ENTER:
       2,SPECIFIC GRAVITY, MOISTURE CONTENT (PERCENT)
         EXAMPLE: 2,0.56,80

 2,0.64,60

IV. ENTER: TREE STEM DIAMETER (CM) AND TREE HEIGHT
    (M, TO NEAREST TENTH).
=22,10.5
```

```
DO YOU WANT TREE REMNANT HEIGHTS CALCULATED AT 1-METER
INTERVALS FROM GROUND ZERO ?
=NO

DO YOU HAVE RADIAL DISTANCES OF TREES FROM GROUND ZERO OR
XY-COORDINATES ? (TYPE 1 FOR DISTANCES, 2 FOR COORDINATES)
=1

HOW MANY DISTANCES DO YOU HAVE (NOT TO EXCEED 115) ?
=17

ENTER ALL DISTANCES (M) IN ASCENDING ORDER:
=3,6,9,12,15,18,21,24,27,30,33,36,39,42,45,48,51

DO YOU WANT TO COMPARE THE TREE REMNANT HEIGHT PROFILE AND
THE LANDING ZONE GEOMETRY REQUIRED FOR A HELICOPTER ?
=YES


THE FOLLOWING HELICOPTER FILES ARE AVAILABLE:
    1. UH-1H, IROQUOIS
    2. UH-1B, IROQUOIS
    3. OH-6A, CAYUSE
    4. CH-47A, CHINOOK
    5. CH-47C, CHINOOK

SELECT A HELICOPTER AND TYPE ITS NUMBER.
=2

SELECT 10.0 OR 15.0 METERS AS TOUCH ZONE RADIUS.
=10

SELECT A DEPARTURE ANGLE WITHIN THE LIMITS OF  22. AND  75. DEGREES.
=35


* * * * * * * * * * * * * * * * * * * * * * * * *

     HELICOPTER                          UH-1B
     DEPARTURE ANGLE (DEG)                35.0
     RADIUS OF TOUCH ZONE (M)             10.0
     WEAPON YIELD (METRIC TONS, TNT)       6.6
```

TREE IDENTIFICATION NUMBER 2
COMMON SPECIES NAME: SHAGBARK HICKORY
MODULUS OF RUPTURE (DYNES/CM SQ) 0.75840000E 09
YOUNG'S MODULUS (DYNES/CM SQ) 0.11901000E 12
WOOD DENSITY (GRAMS/CM CUBED) 1.02

MAXIMUM TREE DIAMETER (CM) 22.
MAXIMUM TREE HEIGHT (M) 11.

****

DISTANCE FROM GROUND ZERO (M)	TREE REMNANT HEIGHT (M)	HEIGHT OF GLIDE PATH (M)
3.00	0.54	0.30
6.00	0.93	0.30
9.00	1.11	0.30
12.00	1.27	1.70
15.00	1.49	3.80
18.00	2.24	5.90
21.00	4.85	8.00
24.00	9.13	10.10
27.00	10.50 *	12.20
30.00	10.50	14.30
33.00	10.50	16.40
36.00	10.50	18.51
39.00	10.50	20.61
42.00	10.50	22.71
45.00	10.50	24.81
48.00	10.50	26.91
51.00	10.50	29.01

* MAXIMUM TREE HEIGHT

* *

DO YOU WANT TO COMPARE DATA FOR:
1. REMNANT PROFILE AND ANOTHER DEPARTURE ANGLE (DA) ?
2. REMNANT PROFILE AND ANOTHER TOUCH ZONE RADIUS (RTZ) ?
3. REMNANT PROFILE AND ANOTHER DA AND RTZ ?
4. REMNANT PROFILE AND ANOTHER HELICOPTER ?
5. NO MORE ?

```
SELECT ONE AND TYPE ITS NUMBER.
=5

DO YOU HAVE ANOTHER TREE SPECIES ?
=NO

WHAT DO YOU WANT TO DO:
 1. EVALUATE ANOTHER SITE USING THE SAME WEAPON YIELD ?
 2. EVALUATE ANOTHER SITE USING A DIFFERENT WEAPON YIELD ?
 3. EVALUATE SAME SITE USING A DIFFERENT WEAPON YIELD ?
 4. END THE PROGRAM ?

SELECT ONE AND TYPE ITS NUMBER.
=4


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```

Vegetation Input Data Format 2 *

Site SS-02

Weapon yield 6.63 Output file name RHF6

Item	Value
1. Maximum wood strength class occurring in the site	5
2. Maximum stem diameter, cm, in the maximum wood strength class	52.
3. Maximum tree height, m to nearest tenth, in the maximum wood strength class	18.5

* This format uses maximum conditions present in a site and evaluates the site as a prospective landing zone by comparing the vertical clearances required by the landing of a helicopter to the vegetation profile of the clearing that results where these extreme conditions exist.

```
* * * * * * * * * * * * * * * * * * * * * * * * *

IS YOUR KNOWLEDGE OF THIS PROGRAM AND ITS OPERATION
SUFFICIENT TO ELIMINATE TYPING THE GENERAL EXPLANATIONS
AND INSTRUCTIONS AND BEGIN IMMEDIATELY WITH THE INPUT
OF DATA ?  (TYPE YES OR NO)
=YES


WHAT IS THE WEAPON YIELD IN METRIC TONS, TNT ?
   EXAMPLE: 10,000 LB GENERAL PURPOSE BOMB HAS A YIELD
            OF 3.6 METRIC TONS, TNT
=6.63

WHICH INPUT FORMAT DO YOU WANT TO USE ?
 (TYPE 1, 2, OR 3)
=2

WHAT IS THE NAME OF THE OUTPUT FILE WHICH IS TO CONTAIN
THE DISTANCES AND REMNANT HEIGHTS ?
=RHF6


*************************************************************
IF YOU DO NOT HAVE THE WOOD STRENGTH CLASS OF THE TREE
SPECIES IN YOUR SITE, EXAMINE THE LIST OF COMMON NAMES
OF TREE SPECIES THAT HAVE BEEN CLASSIFIED BY WOOD
STRENGTH AND COMPILED INTO TWO TABLES IN THE INSTRUCTION
REPORT FOR THIS COMPUTER PROGRAM (TABLES 6 AND 7).
SELECT THE STRENGTH CLASSES HAVING TREES MOST LIKE THOSE
IN THE LANDING SITE IF THE EXACT SPECIES IS NOT INCLUDED
IN THE LIST.
*************************************************************
```

```
TYPE VALUES FOR:
 1. MAXIMUM WOOD STRENGTH CLASS IN THE SITE
 2. MAXIMUM STEM DIAMETER (CM) IN THAT CLASS
 3. MAXIMUM TREE HEIGHT (M, TO NEAREST TENTH) IN
    THAT CLASS
=5,52,18.5

DO YOU WANT TO COMPARE THE TREE REMNANT HEIGHT PROFILE AND
THE LANDING ZONE GEOMETRY REQUIRED FOR A HELICOPTER ?
=YES


THE FOLLOWING HELICOPTER FILES ARE AVAILABLE:
    1. UH-1H, IROQUOIS
    2. UH-1B, IROQUOIS
    3. OH-6A, CAYUSE
    4. CH-47A, CHINOOK
    5. CH-47C, CHINOOK

SELECT A HELICOPTER AND TYPE ITS NUMBER.
=1

SELECT 10.5 OR 15.0 METERS AS TOUCH ZONE RADIUS.
=10.5

SELECT A DEPARTURE ANGLE WITHIN THE LIMITS OF  22. AND  90. DEGREES.
=40


* * * * * * * * * * * * * * * * * * * * * * * * *

     HELICOPTER                              UH-1H
     DEPARTURE ANGLE (DEG)                     40.0
     RADIUS OF TOUCH ZONE (M)                  10.5
     WEAPON YIELD (METRIC TONS, TNT)            6.6

        WOOD STRENGTH CLASS                    5

        MAXIMUM TREE DIAMETER (CM)            52.
        MAXIMUM TREE HEIGHT (M)               19.

              ********************
```

DISTANCE FROM GROUND ZERO (M)	TREE REMNANT HEIGHT (M)	HEIGHT OF GLIDE PATH (M)
3.00	1.53	0.39
4.00	1.94	0.39
5.00	2.39	0.39
6.00	2.77	0.39
7.00	3.10	0.39
8.00	3.47	0.39
9.00	3.96	0.39
10.00	4.70	0.39
11.00	5.85	1.23
12.00	7.60	2.07
13.00	10.00	2.91
14.00	13.00	3.75
15.00	18.50 *	4.59
16.00	18.50	5.42
17.00	18.50	6.26
18.00	18.50	7.10
19.00	18.50	7.94
20.00	18.50	8.78
21.00	18.50	9.62
22.00	18.50	10.46
23.00	18.50	11.30
24.00	18.50	12.14
25.00	18.50	12.98
26.00	18.50	13.82
27.00	18.50	14.65
28.00	18.50	15.49
29.00	18.50	16.33
30.00	18.50	17.17
31.00	18.50	18.01
32.00	18.50	18.85

* MAXIMUM TREE HEIGHT

* *

DO YOU WANT TO COMPARE DATA FOR:

1. REMNANT PROFILE AND ANOTHER DEPARTURE ANGLE (DA) ?
2. REMNANT PROFILE AND ANOTHER TOUCH ZONE RADIUS (RTZ) ?
3. REMNANT PROFILE AND ANOTHER DA AND RTZ ?
4. REMNANT PROFILE AND ANOTHER HELICOPTER ?
5. NO MORE ?

SELECT ONE AND TYPE ITS NUMBER.
=4
ENTER ONE OF THE NUMBERS FROM THE LIST OF AVAILABLE
HELICOPTERS.
=4

SELECT 21.0 OR 26.0 METERS AS TOUCH ZONE RADIUS.
=21

* *

HELICOPTER	CH-47A
DEPARTURE ANGLE (DEG)	90.0
RADIUS OF TOUCH ZONE (M)	21.0
WEAPON YIELD (METRIC TONS, TNT)	6.6
WOOD STRENGTH CLASS	5
MAXIMUM TREE DIAMETER (CM)	52.
MAXIMUM TREE HEIGHT (M)	19.

****

DISTANCE FROM GROUND ZERO (M)	TREE REMNANT HEIGHT (M)	HEIGHT OF GLIDE PATH (M)
3.00	1.53	0.50
4.00	1.94	0.50
5.00	2.39	0.50
6.00	2.77	0.50
7.00	3.10	0.50
8.00	3.47	0.50
9.00	3.96	0.50
10.00	4.70	0.50
11.00	5.85	0.50
12.00	7.60	0.50
13.00	10.00	0.50
14.00	13.00	0.50
15.00	18.50 *	0.50
16.00	18.50	0.50
17.00	18.50	0.50
18.00	18.50	0.50
19.00	18.50	0.50
20.00	18.50	0.50
21.00	18.50	0.50

RADIUS OF TOUCH ZONE

```
* MAXIMUM TREE HEIGHT


* * * * * * * * * * * * * * * * * * * * * * * * *

DO YOU WANT TO COMPARE DATA FOR:
 1. REMNANT PROFILE AND ANOTHER DEPARTURE ANGLE (DA) ?
 2. REMNANT PROFILE AND ANOTHER TOUCH ZONE RADIUS (RTZ) ?
 3. REMNANT PROFILE AND ANOTHER DA AND RTZ ?
 4. REMNANT PROFILE AND ANOTHER HELICOPTER ?
 5. NO MORE ?

SELECT ONE AND TYPE ITS NUMBER.
=5

WHAT DO YOU WANT TO DO:
 1. EVALUATE ANOTHER SITE USING THE SAME WEAPON YIELD ?
 2. EVALUATE ANOTHER SITE USING A DIFFERENT WEAPON YIELD ?
 3. EVALUATE SAME SITE USING A DIFFERENT WEAPON YIELD ?
 4. END THE PROGRAM ?

SELECT ONE AND TYPE ITS NUMBER.
=4


* * * * * * * * * * * * * * * * * * * * * * * * *
```

Vegetation Input Data Format 2 *

Site SS-03

Weapon yield 3.63 Output file name RHF7

Item	Value
1. Maximum wood strength class occurring in the site	3
2. Maximum stem diameter, cm, in the maximum wood strength class	21
3. Maximum tree height, m to nearest tenth, in the maximum wood strength class	8.0

* This format uses maximum conditions present in a site and evaluates the site as a prospective landing zone by comparing the vertical clearances required by the landing of a helicopter to the vegetation profile of the clearing that results where these extreme conditions exist.

Vegetation Input Data Format 2 *

Site SS-03

Weapon yield 6.63 Output file name RHF8

Item	Value
1. Maximum wood strength class occurring in the site	3
2. Maximum stem diameter, cm, in the maximum wood strength class	21
3. Maximum tree height, m to nearest tenth, in the maximum wood strength class	8.0

* This format uses maximum conditions present in a site and evaluates the site as a prospective landing zone by comparing the vertical clearances required by the landing of a helicopter to the vegetation profile of the clearing that results where these extreme conditions exist.

```
* * * * * * * * * * * * * * * * * * * * * * * * *

IS YOUR KNOWLEDGE OF THIS PROGRAM AND ITS OPERATION
SUFFICIENT TO ELIMINATE TYPING THE GENERAL EXPLANATIONS
AND INSTRUCTIONS AND BEGIN IMMEDIATELY WITH THE INPUT
OF DATA ?  (TYPE YES OR NO)
=YES


WHAT IS THE WEAPON YIELD IN METRIC TONS, TNT ?
   EXAMPLE: 10,000 LB GENERAL PURPOSE BOMB HAS A YIELD
            OF 3.6 METRIC TONS, TNT
=3.63

WHICH INPUT FORMAT DO YOU WANT TO USE ?
 (TYPE 1, 2, OR 3)
=2

WHAT IS THE NAME OF THE OUTPUT FILE WHICH IS TO CONTAIN
THE DISTANCES AND REMNANT HEIGHTS ?
=RHF7


************************************************************
IF YOU DO NOT HAVE THE WOOD STRENGTH CLASS OF THE TREE
SPECIES IN YOUR SITE, EXAMINE THE LIST OF COMMON NAMES
OF TREE SPECIES THAT HAVE BEEN CLASSIFIED BY WOOD
STRENGTH AND COMPILED INTO TWO TABLES IN THE INSTRUCTION
REPORT FOR THIS COMPUTER PROGRAM (TABLES 6 AND 7).
SELECT THE STRENGTH CLASSES HAVING TREES MOST LIKE THOSE
IN THE LANDING SITE IF THE EXACT SPECIES IS NOT INCLUDED
IN THE LIST.
************************************************************


TYPE VALUES FOR:
 1. MAXIMUM WOOD STRENGTH CLASS IN THE SITE
 2. MAXIMUM STEM DIAMETER (CM) IN THAT CLASS
 3. MAXIMUM TREE HEIGHT (M, TO NEAREST TENTH) IN
    THAT CLASS
=3,21,8.0
```

```
DO YOU WANT TO COMPARE THE TREE REMNANT HEIGHT PROFILE AND
THE LANDING ZONE GEOMETRY REQUIRED FOR A HELICOPTER ?
=YES


THE FOLLOWING HELICOPTER FILES ARE AVAILABLE:
    1. UH-1H, IROQUOIS
    2. UH-1B, IROQUOIS
    3. OH-6A, CAYUSE
    4. CH-47A, CHINOOK
    5. CH-47C, CHINOOK

SELECT A HELICOPTER AND TYPE ITS NUMBER.
=1

SELECT 10.5 OR 15.0 METERS AS TOUCH ZONE RADIUS.
=15

SELECT A DEPARTURE ANGLE WITHIN THE LIMITS OF  22. AND  90. DEGREES.
=37


* * * * * * * * * * * * * * * * * * * * * * * * *

     HELICOPTER                             UH-1H
     DEPARTURE ANGLE (DEG)                   37.0
     RADIUS OF TOUCH ZONE (M)                15.0
     WEAPON YIELD (METRIC TONS, TNT)          3.6

        WOOD STRENGTH CLASS                   3

        MAXIMUM TREE DIAMETER (CM)           21.
        MAXIMUM TREE HEIGHT (M)               8.

              ********************
```

DISTANCE FROM GROUND ZERO (M)	TREE REMNANT HEIGHT (M)	HEIGHT OF GLIDE PATH (M)
3.00	0.60	0.39
4.00	0.76	0.39
5.00	0.88	0.39
6.00	0.96	0.39
7.00	1.02	0.39
8.00	1.08	0.39
9.00	1.14	0.39
10.00	1.21	0.39
11.00	1.28	0.39
12.00	1.36	0.39
13.00	1.46	0.39
14.00	1.64	0.39
15.00	1.95	0.39
16.00	2.50	1.14
17.00	3.42	1.90
18.00	4.77	2.65
19.00	6.50	3.40
20.00	8.00 *	4.16
21.00	8.00	4.91
22.00	8.00	5.66
23.00	8.00	6.42
24.00	8.00	7.17
25.00	8.00	7.93
26.00	8.00	8.68

* MAXIMUM TREE HEIGHT

* *

DO YOU WANT TO COMPARE DATA FOR:
1. REMNANT PROFILE AND ANOTHER DEPARTURE ANGLE (DA) ?
2. REMNANT PROFILE AND ANOTHER TOUCH ZONE RADIUS (RTZ) ?
3. REMNANT PROFILE AND ANOTHER DA AND RTZ ?
4. REMNANT PROFILE AND ANOTHER HELICOPTER ?
5. NO MORE ?

SELECT ONE AND TYPE ITS NUMBER.
=2

SELECT 10.5 OR 15.0 METERS AS TOUCH ZONE RADIUS.
=10.5

* *

HELICOPTER	UH-1H
DEPARTURE ANGLE (DEG)	37.0
RADIUS OF TOUCH ZONE (M)	10.5
WEAPON YIELD (METRIC TONS, TNT)	3.6
WOOD STRENGTH CLASS	3
MAXIMUM TREE DIAMETER (CM)	21.
MAXIMUM TREE HEIGHT (M)	8.

****

DISTANCE FROM GROUND ZERO (M)	TREE REMNANT HEIGHT (M)	HEIGHT OF GLIDE PATH (M)
3.00	0.60	0.39
4.00	0.76	0.39
5.00	0.88	0.39
6.00	0.96	0.39
7.00	1.02	0.39
8.00	1.08	0.39
9.00	1.14	0.39
10.00	1.21	0.39
11.00	1.28	1.14
12.00	1.36	1.90
13.00	1.46	2.65
14.00	1.64	3.40
15.00	1.95	4.16
16.00	2.50	4.91
17.00	3.42	5.66
18.00	4.77	6.42
19.00	6.50	7.17
20.00	8.00 *	7.93
21.00	8.00	8.68

* MAXIMUM TREE HEIGHT

* *

```
DO YOU WANT TO COMPARE DATA FOR:
 1. REMNANT PROFILE AND ANOTHER DEPARTURE ANGLE (DA) ?
 2. REMNANT PROFILE AND ANOTHER TOUCH ZONE RADIUS (RTZ) ?
 3. REMNANT PROFILE AND ANOTHER DA AND RTZ ?
 4. REMNANT PROFILE AND ANOTHER HELICOPTER ?
 5. NO MORE ?

SELECT ONE AND TYPE ITS NUMBER.
=5

WHAT DO YOU WANT TO DO:
 1. EVALUATE ANOTHER SITE USING THE SAME WEAPON YIELD ?
 2. EVALUATE ANOTHER SITE USING A DIFFERENT WEAPON YIELD ?
 3. EVALUATE SAME SITE USING A DIFFERENT WEAPON YIELD ?
 4. END THE PROGRAM ?

SELECT ONE AND TYPE ITS NUMBER.
=3

WHAT IS THE WEAPON YIELD IN METRIC TONS, TNT ?
=6.63

WHAT IS THE NAME OF THE OUTPUT FILE WHICH IS TO CONTAIN
THE DISTANCES AND REMNANT HEIGHTS ?
=RHF8

DO YOU WANT TO COMPARE THE TREE REMNANT HEIGHT PROFILE AND
THE LANDING ZONE GEOMETRY REQUIRED FOR A HELICOPTER ?
=YES


THE FOLLOWING HELICOPTER FILES ARE AVAILABLE:
    1. UH-1H, IROQUOIS
    2. UH-1B, IROQUOIS
    3. OH-6A, CAYUSE
    4. CH-47A, CHINOOK
    5. CH-47C, CHINOOK

SELECT A HELICOPTER AND TYPE ITS NUMBER.
=1

SELECT 10.5 OR 15.0 METERS AS TOUCH ZONE RADIUS.
=15

SELECT A DEPARTURE ANGLE WITHIN THE LIMITS OF  22. AND  90. DEGREES.
=37
```

* *

HELICOPTER	UH-1H
DEPARTURE ANGLE (DEG)	37.0
RADIUS OF TOUCH ZONE (M)	15.0
WEAPON YIELD (METRIC TONS, TNT)	6.6
WOOD STRENGTH CLASS	3
MAXIMUM TREE DIAMETER (CM)	21.
MAXIMUM TREE HEIGHT (M)	8.

****

DISTANCE FROM GROUND ZERO (M)	TREE REMNANT HEIGHT (M)	HEIGHT OF GLIDE PATH (M)
3.00	0.48	0.39
4.00	0.59	0.39
5.00	0.70	0.39
6.00	0.78	0.39
7.00	0.84	0.39
8.00	0.89	0.39
9.00	0.94	0.39
10.00	0.99	0.39
11.00	1.04	0.39
12.00	1.09	0.39
13.00	1.15	0.39
14.00	1.21	0.39
15.00	1.27	0.39
16.00	1.34	1.14
17.00	1.42	1.90
18.00	1.53	2.65
19.00	1.71	3.40
20.00	2.00	4.16
21.00	2.46	4.91
22.00	3.15	5.66
23.00	4.13	6.42
24.00	5.37	7.17
25.00	6.81	7.93
26.00	8.00 *	8.68

* MAXIMUM TREE HEIGHT

* *

DO YOU WANT TO COMPARE DATA FOR:
1. REMNANT PROFILE AND ANOTHER DEPARTURE ANGLE (DA) ?
2. REMNANT PROFILE AND ANOTHER TOUCH ZONE RADIUS (RTZ) ?
3. REMNANT PROFILE AND ANOTHER DA AND RTZ ?
4. REMNANT PROFILE AND ANOTHER HELICOPTER ?
5. NO MORE ?

SELECT ONE AND TYPE ITS NUMBER.
=3

SELECT 10.5 OR 15.0 METERS AS TOUCH ZONE RADIUS.
=10.5

SELECT A DEPARTURE ANGLE WITHIN THE LIMITS OF 22. AND 90. DEGREES.
=55

* *

HELICOPTER	UH-1H
DEPARTURE ANGLE (DEG)	55.0
RADIUS OF TOUCH ZONE (M)	10.5
WEAPON YIELD (METRIC TONS, TNT)	6.6
WOOD STRENGTH CLASS	3
MAXIMUM TREE DIAMETER (CM)	21.
MAXIMUM TREE HEIGHT (M)	8.

****

DISTANCE FROM GROUND ZERO (M)	TREE REMNANT HEIGHT (M)	HEIGHT OF GLIDE PATH (M)
3.00	0.48	0.39
4.00	0.59	0.39
5.00	0.70	0.39
6.00	0.78	0.39
7.00	0.84	0.39
8.00	0.89	0.39

```
   9.00               0.94               0.39
  10.00               0.99               0.39
  11.00               1.04               1.82
  12.00               1.09               3.25
  13.00               1.15               4.67
  14.00               1.21               6.10
  15.00               1.27               7.53
  16.00               1.34               8.96
  17.00               1.42              10.39
  18.00               1.53              11.82
  19.00               1.71              13.24
  20.00               2.00              14.67
  21.00               2.46              16.10
  22.00               3.15              17.53
  23.00               4.13              18.96
  24.00               5.37              20.38
  25.00               6.81              21.81
  26.00               8.00 *            23.24

* MAXIMUM TREE HEIGHT


* * * * * * * * * * * * * * * * * * * * * * * * *

DO YOU WANT TO COMPARE DATA FOR:
 1. REMNANT PROFILE AND ANOTHER DEPARTURE ANGLE (DA) ?
 2. REMNANT PROFILE AND ANOTHER TOUCH ZONE RADIUS (RTZ) ?
 3. REMNANT PROFILE AND ANOTHER DA AND RTZ ?
 4. REMNANT PROFILE AND ANOTHER HELICOPTER ?
 5. NO MORE ?

SELECT ONE AND TYPE ITS NUMBER.
=5

WHAT DO YOU WANT TO DO:
 1. EVALUATE ANOTHER SITE USING THE SAME WEAPON YIELD ?
 2. EVALUATE ANOTHER SITE USING A DIFFERENT WEAPON YIELD ?
 3. EVALUATE SAME SITE USING A DIFFERENT WEAPON YIELD ?
 4. END THE PROGRAM ?

SELECT ONE AND TYPE ITS NUMBER.
=4


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```

Vegetation Input Data Format 3

Site SS-04

Weapon yield 3.63   Output file name RHE5

Maximum Stem Diameter and Tree Height

Diameter Class		Wood Strength Class 1	2	3	4	5	6
1	Diam, cm	7					
	Height, m	8.0					
2	Diam, cm	9					
	Height, m	10.0					
3	Diam, cm	14					15
	Height, m	15.0					15.0
4	Diam, cm	18	18		16		
	Height, m	12.0	12.0		9.6		
5	Diam, cm	23	24				25
	Height, m	13.5	10.0				13.0
6	Diam, cm	34					
	Height, m	18.0					
7	Diam, cm	46					
	Height, m	16.5					
8	Diam, cm	68					76
	Height, m	20.0					20.0
9	Diam, cm	85					
	Height, m	25.0					

DIAMETER CLASS RANGES

Diameter Class	Strength Class 1	2	3	4	5	6
1	0-7	0-7	0-7	0-7	0-7	0-7
2	7-9	7-10	7-10	7-10	7-10	7-10
3	9-14	10-14	10-15	10-15	10-15	10-15
4	14-18	14-19	15-20	15-20	15-20	15-20
5	18-23	19-24	20-24	20-25	20-25	20-25
6	23-34	24-36	24-37	25-38	25-38	25-38
7	34-46	36-48	37-49	38-50	38-50	38-51
8	46-68	48-72	49-73	50-75	50-75	51-76
9	68-85	72-91	73-91	75-94	75-94	76-95

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IS YOUR KNOWLEDGE OF THIS PROGRAM AND ITS OPERATION
SUFFICIENT TO ELIMINATE TYPING THE GENERAL EXPLANATIONS
AND INSTRUCTIONS AND BEGIN IMMEDIATELY WITH THE INPUT
OF DATA ?  (TYPE YES OR NO)
=YES


WHAT IS THE WEAPON YIELD IN METRIC TONS, TNT ?
   EXAMPLE: 10,000 LB GENERAL PURPOSE BOMB HAS A YIELD
            OF 3.6 METRIC TONS, TNT
=3.63

WHICH INPUT FORMAT DO YOU WANT TO USE ?
 (TYPE 1, 2, OR 3)
=3

WHAT IS THE NAME OF THE OUTPUT FILE WHICH IS TO CONTAIN
THE DISTANCES AND REMNANT HEIGHTS ?
=RHF5


************************************************************
IF YOU DO NOT HAVE THE WOOD STRENGTH CLASS OF THE TREE
SPECIES IN YOUR SITE, EXAMINE THE LIST OF COMMON NAMES
OF TREE SPECIES THAT HAVE BEEN CLASSIFIED BY WOOD
STRENGTH AND COMPILED INTO TWO TABLES IN THE INSTRUCTION
REPORT FOR THIS COMPUTER PROGRAM (TABLES 6 AND 7).
SELECT THE STRENGTH CLASSES HAVING TREES MOST LIKE THOSE
IN THE LANDING SITE IF THE EXACT SPECIES IS NOT INCLUDED
IN THE LIST.
************************************************************


EACH STRENGTH CLASS WILL BE DESIGNATED AND ALL NINE STEM
DIAMETER CLASSES FOR EACH STRENGTH CLASS.  WHEN THE STEM
DIAMETER CLASSES ARE DESIGNATED, TYPE A ZERO (0) IF STEMS
DO NOT OCCUR IN A DIAMETER CLASS, OR ENTER THE MAXIMUM
STEM DIAMETER (CM) AND MAXIMUM TREE HEIGHT (M. TO NEAREST
TENTH) OCCURRING IN THE DIAMETER CLASS.
```

```
ARE THERE ANY TREES IN STRENGTH CLASS  1 ?
=YES

DIAMETER CLASS  1
=7,8.0

DIAMETER CLASS  2
=9,10.0

DIAMETER CLASS  3
=14,15.0

DIAMETER CLASS  4
=18,12.0

DIAMETER CLASS  5
=23,13.5

DIAMETER CLASS  6
=34,18.0

DIAMETER CLASS  7
=46,16.5

DIAMETER CLASS  8
=68,20.0

DIAMETER CLASS  9
=85,25.0


DO YOU WANT TO COMPARE THE TREE REMNANT HEIGHT PROFILE
FOR DIAMETER CLASS  9, STRENGTH CLASS  1 AND THE
LANDING ZONE GEOMETRY REQUIRED FOR A HELICOPTER ?
=NO


ARE THERE ANY TREES IN STRENGTH CLASS  2 ?
=YES

DIAMETER CLASS  1
=0,0
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```
DIAMETER CLASS  2
=0,0

DIAMETER CLASS  3
=0,0

DIAMETER CLASS  4
=18,12.0

DIAMETER CLASS  5
=24,10.0

DIAMETER CLASS  6
=0,0

DIAMETER CLASS  7
=0,0

DIAMETER CLASS  8
=0,0

DIAMETER CLASS  9
=0,0


DO YOU WANT TO COMPARE THE TREE REMNANT HEIGHT PROFILE
FOR DIAMETER CLASS  5, STRENGTH CLASS  2 AND THE
LANDING ZONE GEOMETRY REQUIRED FOR A HELICOPTER ?
=NO


ARE THERE ANY TREES IN STRENGTH CLASS  3 ?
=NO


ARE THERE ANY TREES IN STRENGTH CLASS  4 ?
=YES

DIAMETER CLASS  1
=0,0

DIAMETER CLASS  2
=0,0
```

```
DIAMETER CLASS  3
=0,0

DIAMETER CLASS  4
=16,9.6

DIAMETER CLASS  5
=0,0

DIAMETER CLASS  6
=0,0

DIAMETER CLASS  7
=0,0

DIAMETER CLASS  8
=0,0

DIAMETER CLASS  9
=0,0


DO YOU WANT TO COMPARE THE TREE REMNANT HEIGHT PROFILE
FOR DIAMETER CLASS  4, STRENGTH CLASS  4 AND THE
LANDING ZONE GEOMETRY REQUIRED FOR A HELICOPTER ?
=NO


ARE THERE ANY TREES IN STRENGTH CLASS  5 ?
=NO


ARE THERE ANY TREES IN STRENGTH CLASS  6 ?
=YES

DIAMETER CLASS  1
=0,0

DIAMETER CLASS  2
=0,0

DIAMETER CLASS  3
=15,15.0
```

```
DIAMETER CLASS  4
=0,0

DIAMETER CLASS  5
=25,13.0

DIAMETER CLASS  6
=0,0

DIAMETER CLASS  7
=0,0

DIAMETER CLASS  8
=76,20.0

DIAMETER CLASS  9
=0,0


DO YOU WANT TO COMPARE THE TREE REMNANT HEIGHT PROFILE
FOR DIAMETER CLASS  8, STRENGTH CLASS  6 AND THE
LANDING ZONE GEOMETRY REQUIRED FOR A HELICOPTER ?
=YES


THE FOLLOWING HELICOPTER FILES ARE AVAILABLE:
    1. UH-1H, IROQUOIS
    2. UH-1B, IROQUOIS
    3. OH-6A, CAYUSE
    4. CH-47A, CHINOOK
    5. CH-47C, CHINOOK

SELECT A HELICOPTER AND TYPE ITS NUMBER.
=3

SELECT  5.3 OR  8.0 METERS AS TOUCH ZONE RADIUS.
=8.0

SELECT A DEPARTURE ANGLE WITHIN THE LIMITS OF  22. AND  90. DEGREES.
=60
```

* *

HELICOPTER	OH-6A
DEPARTURE ANGLE (DEG)	60.0
RADIUS OF TOUCH ZONE (M)	8.0
WEAPON YIELD (METRIC TONS, TNT)	3.6
WOOD STRENGTH CLASS	6
MAXIMUM TREE DIAMETER (CM)	76.
MAXIMUM TREE HEIGHT (M)	20.

****

DISTANCE FROM GROUND ZERO (M)	TREE REMNANT HEIGHT (M)	HEIGHT OF GLIDE PATH (M)
3.00	1.80	0.24
4.00	2.35	0.24
5.00	2.82	0.24
6.00	3.24	0.24
7.00	3.76	0.24
8.00	4.57	0.24
9.00	5.95	1.97
10.00	8.23	3.70
11.00	11.35	5.44
12.00	13.00	7.17
13.00	20.00 *	8.90
14.00	20.00	10.63
15.00	20.00	12.36
16.00	20.00	14.10
17.00	20.00	15.83
18.00	20.00	17.56
19.00	20.00	19.29
20.00	20.00	21.02

* MAXIMUM TREE HEIGHT

* *

```
DO YOU WANT TO COMPARE DATA FOR:
 1. REMNANT PROFILE AND ANOTHER DEPARTURE ANGLE (DA) ?
 2. REMNANT PROFILE AND ANOTHER TOUCH ZONE RADIUS (RTZ) ?
 3. REMNANT PROFILE AND ANOTHER DA AND RTZ ?
 4. REMNANT PROFILE AND ANOTHER HELICOPTER ?
 5. NO MORE ?

SELECT ONE AND TYPE ITS NUMBER.
=5

WHAT DO YOU WANT TO DO:
 1. EVALUATE ANOTHER SITE USING THE SAME WEAPON YIELD ?
 2. EVALUATE ANOTHER SITE USING A DIFFERENT WEAPON YIELD ?
 3. END THE PROGRAM ?

SELECT ONE AND TYPE ITS NUMBER.
=3


* * * * * * * * * * * * * * * * * * * * * * * * *
```

PROGRAM FTJPHL

Example 1

INPUT DATA SUMMARY

Sample No.	B
Helicopter	OH-6A
Touch zone radius, m	8
Departure angle, deg	50
Landing zone design	CIRCULAR
Remnant height file name	RHF7
Weapon yield, metric tons TNT	3.63
Number of trees/100 m^2	3.72
Number of species	3

Common names of species:

(1) AMERICAN ELM	(11)
(2) BLACK MAPLE	(12)
(3) CHESTNUT OAK	(13)
(4)	(14)
(5)	(15)
(6)	(16)
(7)	(17)
(8)	(18)
(9)	(19)
(10)	(20)

(Continued)

Example 1 (Continued)

Sample No.	B (CONTINUED)
Helicopter	
Touch zone radius, m	
Departure angle, deg	
Landing zone design	
Remnant height file name	RHF8
Weapon yield, metric tons TNT	6.63
Number of trees/100 m^2	3.72
Number of species	3

Common names of species:

(1)	AMERICAN ELM	(11)	
(2)	BLACK MAPLE	(12)	
(3)	CHESTNUT OAK	(13)	
(4)		(14)	
(5)		(15)	
(6)		(16)	
(7)		(17)	
(8)		(18)	
(9)		(19)	
(10)		(20)	

(Continued)

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* * * * * * * * * * * * * * * * * * * * * * * * *

THE FOLLOWING HELICOPTER FILES ARE AVAILABLE:
    1. UH-1H, IROQUOIS
    2. UH-1B, IROQUOIS
    3. OH-6A, CAYUSE
    4. CH-47A, CHINOOK
    5. CH-47C, CHINOOK

SELECT A HELICOPTER AND TYPE ITS NUMBER.
=3

SELECT    5.25 OR    8.00 METERS AS TOUCH ZONE RADIUS.
=8

SELECT A DEPARTURE ANGLE WITHIN THE RANGE OF  22. AND  66. DEG.
=50

WHICH LANDING ZONE DESIGN DO YOU WANT ?  (TYPE 1 IF CIRCULAR;
TYPE 2 IF RECTANGULAR.)
=1

WHAT IS THE NAME OF THE INPUT FILE THAT CONTAINS THE
DISTANCES AND REMNANT HEIGHTS ?
=RHF7

WHAT IS THE WEAPON YIELD  (METRIC TONS, TNT) ?
=3.63

HOW MANY TREES PER 100 SQ M ARE THERE IN STRENGTH
CLASS  3 DIAMETER CLASS  5 ?
=3.72

HOW MANY SPECIES ARE INCLUDED IN STRENGTH CLASS  3
DIAMETER CLASS  5 (NOT TO EXCEED 20) ?
=3

WHAT IS THE COMMON NAME FOR SPECIES NO.   1
=AMERICAN ELM

WHAT IS THE COMMON NAME FOR SPECIES NO.   2
=BLACK MAPLE

WHAT IS THE COMMON NAME FOR SPECIES NO.   3
=CHESTNUT OAK
```

(Continued)

Example 1 (Continued)

```
* * * * * * * * * * * * * * * * * * * * * * * * *

        DATA FOR THE  OH-6A   CAYUSE
          DEPARTURE ANGLE  (DEG)   50.
          TOUCH ZONE RADIUS  (M)    8.
          CIRCULAR LANDING ZONE
     WEAPON YIELD  (METRIC TONS, TNT)  3.6

            ************************
                VEGETATION DATA
            ************************

     STRENGTH CLASS                    3
     DIAMETER CLASS (CM)               5
     MAXIMUM TREE HEIGHT (M)           8.
     NUMBER OF TREES PER 100 SQ. M     3.72

  NUMBER OF TREES TO BE CLEARED           4

    DIAMETER RANGE OF  20 -  24 CM
    INCLUDING THESE SPECIES:
      AMERICAN ELM
      BLACK MAPLE
      CHESTNUT OAK


* * * * * * * * * * * * * * * * * * * * * * * * *


DO YOU WANT TO RUN ANOTHER REMNANT HEIGHT FILE ?
=YES

WHAT IS THE NAME OF THE INPUT FILE THAT CONTAINS THE
DISTANCES AND REMNANT HEIGHTS ?
=RHF8

WHAT IS THE WEAPON YIELD  (METRIC TONS, TNT) ?
=6.63

HOW MANY TREES PER 100 SQ M ARE THERE IN STRENGTH
CLASS  5 DIAMETER CLASS  2 ?
=3.72
```

(Continued)

```
HOW MANY SPECIES ARE INCLUDED IN STRENGTH CLASS  5
DIAMETER CLASS  2 (NOT TO EXCEED 20) ?
=3

WHAT IS THE COMMON NAME FOR SPECIES NO.   1
=AMERICAN ELM

WHAT IS THE COMMON NAME FOR SPECIES NO.   2
=BLACK MAPLE

WHAT IS THE COMMON NAME FOR SPECIES NO.   3
=CHESTNUT OAK


* * * * * * * * * * * * * * * * * * * * * * * * *

         DATA FOR THE  OH-6A   CAYUSE
           DEPARTURE ANGLE  (DEG)   50.
           TOUCH ZONE RADIUS  (M)    8.
           CIRCULAR LANDING ZONE
      WEAPON YIELD  (METRIC TONS, TNT)  6.6

             ************************
                 VEGETATION DATA
             ************************

      STRENGTH CLASS                       5
      DIAMETER CLASS (CM)                  2
      MAXIMUM TREE HEIGHT (M)              5.
      NUMBER OF TREES PER 100 SQ. M        3.72

   NUMBER OF TREES TO BE CLEARED              2

     DIAMETER RANGE OF   7 -  10 CM
     INCLUDING THESE SPECIES:
       AMERICAN ELM
       BLACK MAPLE
       CHESTNUT OAK


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(Continued)

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DO YOU WANT TO RUN ANOTHER REMNANT HEIGHT FILE ?
=NO


DO YOU WANT TO:
  1. RUN ANOTHER DEPARTURE ANGLE, SAME TOUCH ZONE RADIUS ?
  2. RUN ANOTHER DEPARTURE ANGLE AND ANOTHER RADIUS ?
  3. RUN THE SAME ANGLE AND ANOTHER RADIUS ?
  4. RUN ANOTHER HELICOPTER ?
  5. END THE PROGRAM ?

MAKE A SELECTION AND TYPE ITS NUMBER.
=5



* * * * * * * * * * * * * * * * * * * * * * * * *
```

Example 2

INPUT DATA SUMMARY

Sample No.	C
Helicopter	OH-6A
Touch zone radius, m	8
Departure angle, deg	38
Landing zone design	CIRCULAR
Remnant height file name	RHF10
Weapon yield, metric tons TNT	6.63
Number of trees/100 m^2	3.33
Number of species	1

Common names of species:

(1)	SWEETGUM	(11)	
(2)		(12)	
(3)		(13)	
(4)		(14)	
(5)		(15)	
(6)		(16)	
(7)		(17)	
(8)		(18)	
(9)		(19)	
(10)		(20)	

(Continued)

Sample No.	C (CONTINUED)
Helicopter	
Touch zone radius, m	
Departure angle, deg	
Landing zone design	
Remnant height file name	RHF11
Weapon yield, metric tons TNT	6.63
Number of trees/100 m^2	4.06
Number of species	1

Common names of species:

(1) SHAGBARK HICKORY	(11)
(2)	(12)
(3)	(13)
(4)	(14)
(5)	(15)
(6)	(16)
(7)	(17)
(8)	(18)
(9)	(19)
(10)	(20)

(Continued)

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* * * * * * * * * * * * * * * * * * * * * * * * *

THE FOLLOWING HELICOPTER FILES ARE AVAILABLE:
    1. UH-1H, IROQUOIS
    2. UH-1B, IROQUOIS
    3. OH-6A, CAYUSE
    4. CH-47A, CHINOOK
    5. CH-47C, CHINOOK

SELECT A HELICOPTER AND TYPE ITS NUMBER.
=3

SELECT    5.25 OR    8.00 METERS AS TOUCH ZONE RADIUS.
=8

SELECT A DEPARTURE ANGLE WITHIN THE RANGE OF  22. AND  66. DEG.
=38

WHICH LANDING ZONE DESIGN DO YOU WANT ?  (TYPE 1 IF CIRCULAR;
TYPE 2 IF RECTANGULAR.)
=1

WHAT IS THE NAME OF THE INPUT FILE THAT CONTAINS THE
DISTANCES AND REMNANT HEIGHTS ?
=RHF10

WHAT IS THE WEAPON YIELD  (METRIC TONS, TNT) ?
=6.63

HOW MANY TREES PER 100 SQ M ARE THERE IN STRENGTH
CLASS  4 DIAMETER CLASS  2 ?
=3.33

HOW MANY SPECIES ARE INCLUDED IN STRENGTH CLASS  4
DIAMETER CLASS  2 (NOT TO EXCEED 20) ?
=1

WHAT IS THE COMMON NAME FOR SPECIES NO.    1
=SWEETGUM
```

(Continued)

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        DATA FOR THE  OH-6A   CAYUSE
          DEPARTURE ANGLE  (DEG)   38.
          TOUCH ZONE RADIUS  (M)    8.
          CIRCULAR LANDING ZONE
     WEAPON YIELD  (METRIC TONS, TNT)  6.6

             ************************
                 VEGETATION DATA
             ************************

     STRENGTH CLASS                        4
     DIAMETER CLASS (CM)                   2
     MAXIMUM TREE HEIGHT (M)               9.
     NUMBER OF TREES PER 100 SQ. M         3.33

  NUMBER OF TREES TO BE CLEARED               2

    DIAMETER RANGE OF    7 -  10 CM
    INCLUDING THESE SPECIES:
      SWEETGUM


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DO YOU WANT TO RUN ANOTHER REMNANT HEIGHT FILE ?
=YES

WHAT IS THE NAME OF THE INPUT FILE THAT CONTAINS THE
DISTANCES AND REMNANT HEIGHTS ?
=RHF11

WHAT IS THE WEAPON YIELD  (METRIC TONS, TNT) ?
=6.63

HOW MANY TREES PER 100 SQ M ARE THERE IN STRENGTH
CLASS  5 DIAMETER CLASS  3 ?
=4.06
```

(Continued)

```
HOW MANY SPECIES ARE INCLUDED IN STRENGTH CLASS  5
DIAMETER CLASS  3 (NOT TO EXCEED 20) ?
=1

WHAT IS THE COMMON NAME FOR SPECIES NO.   1
=SHAGBARK HICKORY


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          DATA FOR THE  OH-6A   CAYUSE
            DEPARTURE ANGLE  (DEG)   38.
            TOUCH ZONE RADIUS  (M)    8.
            CIRCULAR LANDING ZONE
        WEAPON YIELD  (METRIC TONS, TNT)  6.6

              ************************
                  VEGETATION DATA
              ************************

        STRENGTH CLASS                        5
        DIAMETER CLASS (CM)                   3
        MAXIMUM TREE HEIGHT (M)              11.
        NUMBER OF TREES PER 100 SQ. M         4.06

     NUMBER OF TREES TO BE CLEARED               4

       DIAMETER RANGE OF  10 -  15 CM
       INCLUDING THESE SPECIES:
         SHAGBARK HICKORY


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DO YOU WANT TO RUN ANOTHER REMNANT HEIGHT FILE ?
=NO
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(Continued)

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DO YOU WANT TO:
  1. RUN ANOTHER DEPARTURE ANGLE, SAME TOUCH ZONE RADIUS ?
  2. RUN ANOTHER DEPARTURE ANGLE AND ANOTHER RADIUS ?
  3. RUN THE SAME ANGLE AND ANOTHER RADIUS ?
  4. RUN ANOTHER HELICOPTER ?
  5. END THE PROGRAM ?

MAKE A SELECTION AND TYPE ITS NUMBER.
=5
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Example 3

INPUT DATA SUMMARY

Sample No.	D
Helicopter	UH-1H
Touch zone radius, m	15
Departure angle, deg	45
Landing zone design	RECTANGULAR
Remnant height file name	RHF6
Weapon yield, metric tons TNT	6.63
Number of trees/100 m^2	2
Number of species	2

Common names of species:

(1)	DOGWOOD	(11)	
(2)	POST OAK	(12)	
(3)		(13)	
(4)		(14)	
(5)		(15)	
(6)		(16)	
(7)		(17)	
(8)		(18)	
(9)		(19)	
(10)		(20)	

(Continued)

Sample No.	D (CONTINUED)
Helicopter	______
Touch zone radius, m	10.5
Departure angle, deg	______
Landing zone design	RECTANGULAR
Remnant height file name	______
Weapon yield, metric tons TNT	______
Number of trees/100 m^2	______
Number of species	______

Common names of species:

(1) ______	(11) ______
(2) ______	(12) ______
(3) ______	(13) ______
(4) ______	(14) ______
(5) ______	(15) ______
(6) ______	(16) ______
(7) ______	(17) ______
(8) ______	(18) ______
(9) ______	(19) ______
(10) ______	(20) ______

(Continued)

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THE FOLLOWING HELICOPTER FILES ARE AVAILABLE:
    1. UH-1H, IROQUOIS
    2. UH-1B, IROQUOIS
    3. OH-6A, CAYUSE
    4. CH-47A, CHINOOK
    5. CH-47C, CHINOOK

SELECT A HELICOPTER AND TYPE ITS NUMBER.
=1

SELECT   10.50 OR   15.00 METERS AS TOUCH ZONE RADIUS.
=15

SELECT A DEPARTURE ANGLE WITHIN THE RANGE OF  22. AND  90. DEG.
=45

WHICH LANDING ZONE DESIGN DO YOU WANT ?  (TYPE 1 IF CIRCULAR;
TYPE 2 IF RECTANGULAR.)
=2

WHAT IS THE NAME OF THE INPUT FILE THAT CONTAINS THE
DISTANCES AND REMNANT HEIGHTS ?
=RHF6

WHAT IS THE WEAPON YIELD  (METRIC TONS, TNT) ?
=6.63

HOW MANY TREES PER 100 SQ M ARE THERE IN STRENGTH
CLASS  5 DIAMETER CLASS  8 ?
=2

HOW MANY SPECIES ARE INCLUDED IN STRENGTH CLASS  5
DIAMETER CLASS  8 (NOT TO EXCEED 20) ?
=2

WHAT IS THE COMMON NAME FOR SPECIES NO.   1
=DOGWOOD

WHAT IS THE COMMON NAME FOR SPECIES NO.   2
=POST OAK
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(Continued)

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        DATA FOR THE  UH-1H  IROQUOIS
          DEPARTURE ANGLE  (DEG)   45.
          TOUCH ZONE RADIUS  (M)   15.
          RECTANGULAR LANDING ZONE
     WEAPON YIELD  (METRIC TONS, TNT)  6.6

           ************************
               VEGETATION DATA
           ************************

     STRENGTH CLASS                        5
     DIAMETER CLASS (CM)                   8
     MAXIMUM TREE HEIGHT (M)              19.
     NUMBER OF TREES PER 100 SQ. M         2.00

  NUMBER OF TREES TO BE CLEARED             19

    DIAMETER RANGE OF  50 -  75 CM
    INCLUDING THESE SPECIES:
      DOGWOOD
      POST OAK


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DO YOU WANT TO RUN ANOTHER REMNANT HEIGHT FILE ?
=NO


DO YOU WANT TO:
  1. RUN ANOTHER DEPARTURE ANGLE, SAME TOUCH ZONE RADIUS ?
  2. RUN ANOTHER DEPARTURE ANGLE AND ANOTHER RADIUS ?
  3. RUN THE SAME ANGLE AND ANOTHER RADIUS ?
  4. RUN ANOTHER HELICOPTER ?
  5. END THE PROGRAM ?

MAKE A SELECTION AND TYPE ITS NUMBER.
=3
```

(Continued)

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TYPE THE TOUCH ZONE RADIUS (M).
=10.5

WHICH LANDING ZONE DESIGN DO YOU WANT ?  (TYPE 1 IF CIRCULAR;
TYPE 2 IF RECTANGULAR.)
=2


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         DATA FOR THE  UH-1H  IROQUOIS
           DEPARTURE ANGLE  (DEG)   45.
           TOUCH ZONE RADIUS  (M)   11.
           RECTANGULAR LANDING ZONE
      WEAPON YIELD  (METRIC TONS, TNT)  6.6

            ************************
                 VEGETATION DATA
            ************************

      STRENGTH CLASS                         5
      DIAMETER CLASS (CM)                    8
      MAXIMUM TREE HEIGHT (M)               19.
      NUMBER OF TREES PER 100 SQ. M          2.00

   NUMBER OF TREES TO BE CLEARED                7

     DIAMETER RANGE OF  50 -  75 CM
     INCLUDING THESE SPECIES:
       DOGWOOD
       POST OAK


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DO YOU WANT TO RUN ANOTHER REMNANT HEIGHT FILE ?
=NO
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(Continued)

Example 3 (Concluded)

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DO YOU WANT TO:
  1. RUN ANOTHER DEPARTURE ANGLE, SAME TOUCH ZONE RADIUS ?
  2. RUN ANOTHER DEPARTURE ANGLE AND ANOTHER RADIUS ?
  3. RUN THE SAME ANGLE AND ANOTHER RADIUS ?
  4. RUN ANOTHER HELICOPTER ?
  5. END THE PROGRAM ?

MAKE A SELECTION AND TYPE ITS NUMBER.
=5
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Example 4

INPUT DATA SUMMARY

Sample No.	F
Helicopter	CH-47C
Touch zone radius, m	26
Departure angle, deg	48
Landing zone design	CIRCULAR
Remnant height file name	RHF5
Weapon yield, metric tons TNT	3.63

Diameter class 1 Strength Class 1

Number of trees/100 m^2 0.56

Number of species 1

Common names of species:

(1) LODGEPOLE PINE	(4)
(2)	(5)
(3)	(6)

Diameter class 2 Strength class 1

Number of trees/100 m^2 1.22

Number of species 1

Common names of species:

(1) LODGEPOLE PINE	(4)
(2)	(5)
(3)	(6)

(Continued)

Diameter class 3 Strength Class 1

Number of trees/100 m^2 0.85

Number of species 1

Common names of species:

(1) EASTERN WHITE PINE (4) ______

(2) ______ (5) ______

(3) ______ (6) ______

Diameter class 4 Strength Class 1

Number of trees/100 m^2 0.33

Number of species 1

Common names of species:

(1) NOBLE FIR (4) ______

(2) ______ (5) ______

(3) ______ (6) ______

Diameter class 5 Strength class 1

Number of trees/100 m^2 0.95

Number of species 1

Common names of species:

(1) LODGEPOLE PINE (4) ______

(2) ______ (5) ______

(3) ______ (6) ______

(Continued)

Diameter class 6 Strength Class 1

Number of trees/100 m^2 0.15

Number of species 1

Common names of species:

(1) ENGLEMANN SPRUCE (4) ____

(2) ____ (5) ____

(3) ____ (6) ____

Diameter class 7 Strength Class 1

Number of trees/100 m^2 0.42

Number of species 1

Common names of species:

(1) BLACK SPRUCE (4) ____

(2) ____ (5) ____

(3) ____ (6) ____

Diameter class 8 Strength class 1

Number of trees/100 m^2 0.26

Number of species 1

Common names of species:

(1) EASTERN WHITE PINE (4) ____

(2) ____ (5) ____

(3) ____ (6) ____

(Continued)

Diameter class 9 Strength Class 1

Number of trees/100 m^2 0.06

Number of species 1

Common names of species:

(1) ENGLEMANN SPRUCE (4) ____

(2) ____ (5) ____

(3) ____ (6) ____

Diameter class 4 Strength Class 2

Number of trees/100 m^2 2.41

Number of species 2

Common names of species:

(1) PONDEROSA PINE (4) ____

(2) YELLOW POPLAR (5) ____

(3) ____ (6) ____

Diameter class 5 Strength class 2

Number of trees/100 m^2 1.05

Number of species 1

Common names of species:

(1) PONDEROSA PINE (4) ____

(2) ____ (5) ____

(3) ____ (6) ____

(Continued)

Diameter class 4 Strength Class 4

Number of trees/100 m^2 0.98

Number of species 3

Common names of species:

(1) BLACK GUM (4) ____

(2) EASTERN RED CEDAR (5) ____

(3) PECAN HICKORY (6) ____

Diameter class 3 Strength Class 6

Number of trees/100 m^2 0.07

Number of species 1

Common names of species:

(1) BLACK IRONWOOD (4) ____

(2) ____ (5) ____

(3) ____ (6) ____

Diameter class 5 Strength class 6

Number of trees/100 m^2 0.12

Number of species 1

Common names of species:

(1) BLACK IRONWOOD (4) ____

(2) ____ (5) ____

(3) ____ (6) ____

(Continued)

Diameter class 8 Strength Class 6

Number of trees/100 m^2 0.07

Number of species 1

Common names of species:

(1) BLACK IRONWOOD (4) ____

(2) ____ (5) ____

(3) ____ (6) ____

Diameter class ____ Strength Class ____

Number of trees/100 m^2 ____

Number of species ____

Common names of species:

(1) ____ (4) ____

(2) ____ (5) ____

(3) ____ (6) ____

Diameter class ____ Strength class ____

Number of trees/100 m^2 ____

Number of species ____

Common names of species:

(1) ____ (4) ____

(2) ____ (5) ____

(3) ____ (6) ____

(Continued)

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THE FOLLOWING HELICOPTER FILES ARE AVAILABLE:
    1. UH-1H, IROQUOIS
    2. UH-1B, IROQUOIS
    3. OH-6A, CAYUSE
    4. CH-47A, CHINOOK
    5. CH-47C, CHINOOK

SELECT A HELICOPTER AND TYPE ITS NUMBER.
=5

SELECT   26.00 OR   17.25 METERS AS TOUCH ZONE RADIUS.
=26

SELECT A DEPARTURE ANGLE WITHIN THE RANGE OF  22. AND  66. DEG.
=48

WHICH LANDING ZONE DESIGN DO YOU WANT ?  (TYPE 1 IF CIRCULAR;
TYPE 2 IF RECTANGULAR.)
=1

WHAT IS THE NAME OF THE INPUT FILE THAT CONTAINS THE
DISTANCES AND REMNANT HEIGHTS ?
=RHF5

WHAT IS THE WEAPON YIELD  (METRIC TONS, TNT) ?
=3.63

HOW MANY TREES PER 100 SQ M ARE THERE IN STRENGTH
CLASS  1 DIAMETER CLASS  1 ?
=0.56

HOW MANY SPECIES ARE INCLUDED IN STRENGTH CLASS  1
DIAMETER CLASS  1 (NOT TO EXCEED 20) ?
=1

WHAT IS THE COMMON NAME FOR SPECIES NO.   1
=LODGEPOLE PINE
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(Continued)

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          DATA FOR THE  CH-47C  CHINOOK
            DEPARTURE ANGLE  (DEG)   48.
            TOUCH ZONE RADIUS  (M)   26.
            CIRCULAR LANDING ZONE
       WEAPON YIELD  (METRIC TONS, TNT)  3.6

             ************************
                 VEGETATION DATA
             ************************

       STRENGTH CLASS                          1
       DIAMETER CLASS (CM)                     1
       MAXIMUM TREE HEIGHT (M)                 8.
       NUMBER OF TREES PER 100 SQ. M           0.56

    NUMBER OF TREES TO BE CLEARED                 2

      DIAMETER RANGE OF   0 -   7 CM
      INCLUDING THESE SPECIES:
        LODGEPOLE PINE



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HOW MANY TREES PER 100 SQ M ARE THERE IN STRENGTH
CLASS  1 DIAMETER CLASS  2 ?
=1.22

HOW MANY SPECIES ARE INCLUDED IN STRENGTH CLASS  1
DIAMETER CLASS  2 (NOT TO EXCEED 20) ?
=1

WHAT IS THE COMMON NAME FOR SPECIES NO.   1
=LODGEPOLE PINE
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(Continued)

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          DATA FOR THE  CH-47C  CHINOOK
            DEPARTURE ANGLE  (DEG)   48.
            TOUCH ZONE RADIUS  (M)   26.
            CIRCULAR LANDING ZONE
       WEAPON YIELD  (METRIC TONS, TNT)  3.6

             ************************
                 VEGETATION DATA
             ************************

       STRENGTH CLASS                        1
       DIAMETER CLASS (CM)                   2
       MAXIMUM TREE HEIGHT (M)              10.
       NUMBER OF TREES PER 100 SQ. M         1.22

    NUMBER OF TREES TO BE CLEARED               7

      DIAMETER RANGE OF   7 -   9 CM
      INCLUDING THESE SPECIES:
        LODGEPOLE PINE


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HOW MANY TREES PER 100 SQ M ARE THERE IN STRENGTH
CLASS  1 DIAMETER CLASS  3 ?
=0.85

HOW MANY SPECIES ARE INCLUDED IN STRENGTH CLASS  1
DIAMETER CLASS  3 (NOT TO EXCEED 20) ?
=1

WHAT IS THE COMMON NAME FOR SPECIES NO.   1
=EASTERN WHITE PINE
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(Continued)

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          DATA FOR THE  CH-47C  CHINOOK
            DEPARTURE ANGLE  (DEG)   48.
            TOUCH ZONE RADIUS  (M)   26.
            CIRCULAR LANDING ZONE
       WEAPON YIELD  (METRIC TONS, TNT)  3.6

               ************************
                   VEGETATION DATA
               ************************

       STRENGTH CLASS                          1
       DIAMETER CLASS (CM)                     3
       MAXIMUM TREE HEIGHT (M)                15.
       NUMBER OF TREES PER 100 SQ. M           0.85

    NUMBER OF TREES TO BE CLEARED                 7

      DIAMETER RANGE OF    9 -  14 CM
      INCLUDING THESE SPECIES:
        EASTERN WHITE PINE



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HOW MANY TREES PER 100 SQ M ARE THERE IN STRENGTH
CLASS  1 DIAMETER CLASS  4 ?
=.33

HOW MANY SPECIES ARE INCLUDED IN STRENGTH CLASS  1
DIAMETER CLASS  4 (NOT TO EXCEED 20) ?
=1

WHAT IS THE COMMON NAME FOR SPECIES NO.   1
=NOBLE FIR
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(Continued)

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         DATA FOR THE  CH-47C  CHINOOK
           DEPARTURE ANGLE  (DEG)   48.
           TOUCH ZONE RADIUS  (M)   26.
           CIRCULAR LANDING ZONE
      WEAPON YIELD  (METRIC TONS, TNT)  3.6

            ************************
                VEGETATION DATA
            ************************

      STRENGTH CLASS                      1
      DIAMETER CLASS (CM)                 4
      MAXIMUM TREE HEIGHT (M)            12.
      NUMBER OF TREES PER 100 SQ. M       0.33

   NUMBER OF TREES TO BE CLEARED            4

     DIAMETER RANGE OF  14 -  18 CM
     INCLUDING THESE SPECIES:
       NOBLE FIR


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HOW MANY TREES PER 100 SQ M ARE THERE IN STRENGTH
CLASS  1 DIAMETER CLASS  5 ?
=.95

HOW MANY SPECIES ARE INCLUDED IN STRENGTH CLASS  1
DIAMETER CLASS  5 (NOT TO EXCEED 20) ?
=1

WHAT IS THE COMMON NAME FOR SPECIES NO.   1
=LODGEPOLE PINE
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(Continued)

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          DATA FOR THE  CH-47C  CHINOOK
            DEPARTURE ANGLE  (DEG)   48.
            TOUCH ZONE RADIUS  (M)   26.
            CIRCULAR LANDING ZONE
       WEAPON YIELD  (METRIC TONS, TNT)  3.6

            ************************
                VEGETATION DATA
            ************************

       STRENGTH CLASS                    1
       DIAMETER CLASS (CM)               5
       MAXIMUM TREE HEIGHT (M)          14.
       NUMBER OF TREES PER 100 SQ. M     0.95

    NUMBER OF TREES TO BE CLEARED         14

      DIAMETER RANGE OF  18 -  23 CM
      INCLUDING THESE SPECIES:
        LODGEPOLE PINE


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HOW MANY TREES PER 100 SQ M ARE THERE IN STRENGTH
CLASS  1 DIAMETER CLASS  6 ?
=.15

HOW MANY SPECIES ARE INCLUDED IN STRENGTH CLASS  1
DIAMETER CLASS  6 (NOT TO EXCEED 20) ?
=1

WHAT IS THE COMMON NAME FOR SPECIES NO.   1
=ENGLEMANN SPRUCE
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(Continued)

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          DATA FOR THE  CH-47C  CHINOOK
            DEPARTURE ANGLE  (DEG)   48.
            TOUCH ZONE RADIUS  (M)   26.
            CIRCULAR LANDING ZONE
       WEAPON YIELD  (METRIC TONS, TNT)  3.6

             *************************
                  VEGETATION DATA
             *************************

       STRENGTH CLASS                         1
       DIAMETER CLASS (CM)                    6
       MAXIMUM TREE HEIGHT (M)               18.
       NUMBER OF TREES PER 100 SQ. M          0.15

    NUMBER OF TREES TO BE CLEARED               3

      DIAMETER RANGE OF  23 -  34 CM
      INCLUDING THESE SPECIES:
        ENGLEMANN SPRUCE


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HOW MANY TREES PER 100 SQ M ARE THERE IN STRENGTH
CLASS  1 DIAMETER CLASS  7 ?
=.42

HOW MANY SPECIES ARE INCLUDED IN STRENGTH CLASS  1
DIAMETER CLASS  7 (NOT TO EXCEED 20) ?
=1

WHAT IS THE COMMON NAME FOR SPECIES NO.   1
=BLACK SPRUCE
```

(Continued)

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          DATA FOR THE  CH-47C  CHINOOK
            DEPARTURE ANGLE  (DEG)   48.
            TOUCH ZONE RADIUS  (M)   26.
            CIRCULAR LANDING ZONE
       WEAPON YIELD  (METRIC TONS, TNT)  3.6

             ************************
                 VEGETATION DATA
             ************************

       STRENGTH CLASS                         1
       DIAMETER CLASS (CM)                    7
       MAXIMUM TREE HEIGHT (M)               17.
       NUMBER OF TREES PER 100 SQ. M          0.42

    NUMBER OF TREES TO BE CLEARED                8

      DIAMETER RANGE OF  34 -  46 CM
      INCLUDING THESE SPECIES:
        BLACK SPRUCE



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HOW MANY TREES PER 100 SQ M ARE THERE IN STRENGTH
CLASS  1 DIAMETER CLASS  8 ?
=.26

HOW MANY SPECIES ARE INCLUDED IN STRENGTH CLASS  1
DIAMETER CLASS  8 (NOT TO EXCEED 20) ?
=1

WHAT IS THE COMMON NAME FOR SPECIES NO.   1
=EASTERN WHITE PINE
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(Continued)

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          DATA FOR THE  CH-47C  CHINOOK
            DEPARTURE ANGLE  (DEG)   48.
            TOUCH ZONE RADIUS  (M)   26.
            CIRCULAR LANDING ZONE
       WEAPON YIELD  (METRIC TONS, TNT)  3.6

             ************************
                 VEGETATION DATA
             ************************

       STRENGTH CLASS                        1
       DIAMETER CLASS (CM)                   8
       MAXIMUM TREE HEIGHT (M)              20.
       NUMBER OF TREES PER 100 SQ. M         0.26

    NUMBER OF TREES TO BE CLEARED               6

      DIAMETER RANGE OF  46 -  68 CM
      INCLUDING THESE SPECIES:
        EASTERN WHITE PINE


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HOW MANY TREES PER 100 SQ M ARE THERE IN STRENGTH
CLASS  1 DIAMETER CLASS  9 ?
=.06

HOW MANY SPECIES ARE INCLUDED IN STRENGTH CLASS  1
DIAMETER CLASS  9 (NOT TO EXCEED 20) ?
=1

WHAT IS THE COMMON NAME FOR SPECIES NO.   1
=ENGLEMANN SPRUCE
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(Continued)

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          DATA FOR THE  CH-47C  CHINOOK
            DEPARTURE ANGLE  (DEG)   48.
            TOUCH ZONE RADIUS  (M)   26.
            CIRCULAR LANDING ZONE
       WEAPON YIELD  (METRIC TONS, TNT)  3.6

             ************************
                 VEGETATION DATA
             ************************

       STRENGTH CLASS                          1
       DIAMETER CLASS (CM)                     9
       MAXIMUM TREE HEIGHT (M)                25.
       NUMBER OF TREES PER 100 SQ. M           0.06

    NUMBER OF TREES TO BE CLEARED               2

      DIAMETER RANGE OF  68 -  85 CM
      INCLUDING THESE SPECIES:
        ENGLEMANN SPRUCE



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HOW MANY TREES PER 100 SQ M ARE THERE IN STRENGTH
CLASS  2 DIAMETER CLASS  4 ?
=2.41

HOW MANY SPECIES ARE INCLUDED IN STRENGTH CLASS  2
DIAMETER CLASS  4 (NOT TO EXCEED 20) ?
=2

WHAT IS THE COMMON NAME FOR SPECIES NO.   1
=PONDEROSA PINE

WHAT IS THE COMMON NAME FOR SPECIES NO.   2
=YELLOW POPLAR
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(Continued)

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          DATA FOR THE  CH-47C  CHINOOK
            DEPARTURE ANGLE  (DEG)   48.
            TOUCH ZONE RADIUS  (M)   26.
            CIRCULAR LANDING ZONE
       WEAPON YIELD  (METRIC TONS, TNT)  3.6

             ************************
                 VEGETATION DATA
             ************************

       STRENGTH CLASS                       2
       DIAMETER CLASS (CM)                  4
       MAXIMUM TREE HEIGHT (M)             12.
       NUMBER OF TREES PER 100 SQ. M        2.41

    NUMBER OF TREES TO BE CLEARED            37

      DIAMETER RANGE OF  14 -  19 CM
      INCLUDING THESE SPECIES:
        PONDEROSA PINE
        YELLOW POPLAR



* * * * * * * * * * * * * * * * * * * * * * * * *


* * * * * * * * * * * * * * * * * * * * * * * * *

HOW MANY TREES PER 100 SQ M ARE THERE IN STRENGTH
CLASS  2 DIAMETER CLASS  5 ?
=1.05

HOW MANY SPECIES ARE INCLUDED IN STRENGTH CLASS  2
DIAMETER CLASS  5 (NOT TO EXCEED 20) ?
=1

WHAT IS THE COMMON NAME FOR SPECIES NO.   1
=PONDEROSA PINE
```

(Continued)

```
* * * * * * * * * * * * * * * * * * * * * * * * *

          DATA FOR THE  CH-47C  CHINOOK
            DEPARTURE ANGLE  (DEG)   48.
            TOUCH ZONE RADIUS  (M)   26.
            CIRCULAR LANDING ZONE
       WEAPON YIELD  (METRIC TONS, TNT)  3.6

             ************************
                 VEGETATION DATA
             ************************

       STRENGTH CLASS                        2
       DIAMETER CLASS (CM)                   5
       MAXIMUM TREE HEIGHT (M)              10.
       NUMBER OF TREES PER 100 SQ. M         1.05

    NUMBER OF TREES TO BE CLEARED              17

      DIAMETER RANGE OF  19 -  24 CM
      INCLUDING THESE SPECIES:
        PONDEROSA PINE



* * * * * * * * * * * * * * * * * * * * * * * * *



* * * * * * * * * * * * * * * * * * * * * * * * *

HOW MANY TREES PER 100 SQ M ARE THERE IN STRENGTH
CLASS  4 DIAMETER CLASS  4 ?
=.98

HOW MANY SPECIES ARE INCLUDED IN STRENGTH CLASS  4
DIAMETER CLASS  4 (NOT TO EXCEED 20) ?
=3

WHAT IS THE COMMON NAME FOR SPECIES NO.   1
=BLACK GUM

WHAT IS THE COMMON NAME FOR SPECIES NO.   2
=EASTERN RED CEDAR

WHAT IS THE COMMON NAME FOR SPECIES NO.   3
=PECAN HICKORY
```

(Continued)

```
* * * * * * * * * * * * * * * * * * * * * * * * *

        DATA FOR THE  CH-47C  CHINOOK
          DEPARTURE ANGLE  (DEG)   48.
          TOUCH ZONE RADIUS  (M)   26.
          CIRCULAR LANDING ZONE
     WEAPON YIELD  (METRIC TONS, TNT)  3.6

             ************************
                 VEGETATION DATA
             ************************

     STRENGTH CLASS                         4
     DIAMETER CLASS (CM)                    4
     MAXIMUM TREE HEIGHT (M)               10.
     NUMBER OF TREES PER 100 SQ. M          0.98

   NUMBER OF TREES TO BE CLEARED              18

     DIAMETER RANGE OF  15 -  20 CM
     INCLUDING THESE SPECIES:
       BLACK GUM
       EASTERN RED CEDAR
       PECAN HICKORY


* * * * * * * * * * * * * * * * * * * * * * * * *



* * * * * * * * * * * * * * * * * * * * * * * * *

HOW MANY TREES PER 100 SQ M ARE THERE IN STRENGTH
CLASS  6 DIAMETER CLASS  3 ?
=.07

HOW MANY SPECIES ARE INCLUDED IN STRENGTH CLASS  6
DIAMETER CLASS  3 (NOT TO EXCEED 20) ?
=1

WHAT IS THE COMMON NAME FOR SPECIES NO.   1
=BLACK IRONWOOD
```

(Continued)

```
* * * * * * * * * * * * * * * * * * * * * * * * *

          DATA FOR THE  CH-47C  CHINOOK
            DEPARTURE ANGLE  (DEG)   48.
            TOUCH ZONE RADIUS  (M)   26.
            CIRCULAR LANDING ZONE
       WEAPON YIELD  (METRIC TONS, TNT)  3.6

             ************************
                 VEGETATION DATA
             ************************

       STRENGTH CLASS                         6
       DIAMETER CLASS (CM)                    3
       MAXIMUM TREE HEIGHT (M)               15.
       NUMBER OF TREES PER 100 SQ. M          0.07

    NUMBER OF TREES TO BE CLEARED               1

      DIAMETER RANGE OF  10 -  15 CM
      INCLUDING THESE SPECIES:
        BLACK IRONWOOD


* * * * * * * * * * * * * * * * * * * * * * * * *


* * * * * * * * * * * * * * * * * * * * * * * * *

HOW MANY TREES PER 100 SQ M ARE THERE IN STRENGTH
CLASS  6 DIAMETER CLASS  5 ?
=.12

HOW MANY SPECIES ARE INCLUDED IN STRENGTH CLASS  6
DIAMETER CLASS  5 (NOT TO EXCEED 20) ?
=1

WHAT IS THE COMMON NAME FOR SPECIES NO.   1
=BLACK IRONWOOD
```

(Continued)

```
* * * * * * * * * * * * * * * * * * * * * * * * *

         DATA FOR THE  CH-47C  CHINOOK
           DEPARTURE ANGLE  (DEG)   48.
           TOUCH ZONE RADIUS  (M)   26.
           CIRCULAR LANDING ZONE
      WEAPON YIELD  (METRIC TONS, TNT)  3.6

              ************************
                  VEGETATION DATA
              ************************

      STRENGTH CLASS                          6
      DIAMETER CLASS (CM)                     5
      MAXIMUM TREE HEIGHT (M)                13.
      NUMBER OF TREES PER 100 SQ. M           0.12

   NUMBER OF TREES TO BE CLEARED                 3

     DIAMETER RANGE OF  20 -  25 CM
     INCLUDING THESE SPECIES:
       BLACK IRONWOOD


* * * * * * * * * * * * * * * * * * * * * * * * *


* * * * * * * * * * * * * * * * * * * * * * * * *

HOW MANY TREES PER 100 SQ M ARE THERE IN STRENGTH
CLASS  6 DIAMETER CLASS  8 ?
=.07

HOW MANY SPECIES ARE INCLUDED IN STRENGTH CLASS  6
DIAMETER CLASS  8 (NOT TO EXCEED 20) ?
=1

WHAT IS THE COMMON NAME FOR SPECIES NO.   1
=BLACK IRONWOOD
```

(Continued)

```
* * * * * * * * * * * * * * * * * * * * * * * * *

          DATA FOR THE  CH-47C  CHINOOK
            DEPARTURE ANGLE  (DEG)   48.
            TOUCH ZONE RADIUS  (M)   26.
            CIRCULAR LANDING ZONE
       WEAPON YIELD  (METRIC TONS, TNT)  3.6

             ************************
                  VEGETATION DATA
             ************************

       STRENGTH CLASS                          6
       DIAMETER CLASS (CM)                     8
       MAXIMUM TREE HEIGHT (M)                20.
       NUMBER OF TREES PER 100 SQ. M           0.07

    NUMBER OF TREES TO BE CLEARED                 2

      DIAMETER RANGE OF  51 -  76 CM
      INCLUDING THESE SPECIES:
        BLACK IRONWOOD


* * * * * * * * * * * * * * * * * * * * * * * * *


DO YOU WANT TO RUN ANOTHER REMNANT HEIGHT FILE ?
=NO


DO YOU WANT TO:
  1. RUN ANOTHER DEPARTURE ANGLE, SAME TOUCH ZONE RADIUS ?
  2. RUN ANOTHER DEPARTURE ANGLE AND ANOTHER RADIUS ?
  3. RUN THE SAME ANGLE AND ANOTHER RADIUS ?
  4. RUN ANOTHER HELICOPTER ?
  5. END THE PROGRAM ?

MAKE A SELECTION AND TYPE ITS NUMBER.
=5



* * * * * * * * * * * * * * * * * * * * * * * * *
```

APPENDIX D: DESCRIPTION OF MATHEMATICS INVOLVED IN PROGRAM FTJPRR

1. The portion of program FTJPRH in which the actual calculations relevant to predicting the tree remnant height occur is nothing more than a computer-coded solution of a detailed nomograph[27]* (Figure D1). It is comprised of six graphs upon which there are families of curves derived from scaling factors produced by a finite difference solution. Because this type solution, even as a computer program, was a very complex and expensive method of making these remnant height predictions, the nomograph was produced, and the equations of the curves are used in program FTJPRH. The nomograph is based on a set of field data[1] that will be designated hereafter as the reference case. Each problem is solved by converting the data describing its given conditions to comparable data for the reference case and solving that reference case.

2. There are 12 equations that are derivations from the nomograph included in this computer code, and 9 of these are used to predict tree remnant heights for specific reference case tree stem diameters. These equations are:

a. Equation 1. This equation converts the stem diameter that is input to the reference case diameter (DOS) (graph 1 in Figure D1).

$$DOS = \frac{DI}{\sqrt{\dfrac{1.2(10^{11})RHO}{0.8E}}}$$

where

DI = stem diameter of input tree**

$1.2(10^{11})$ = Young's modulus of reference case

RHO = wood density of input tree

0.8 = wood density of reference case

E = Young's modulus of input tree

---

* Raised numerals refer to similarly numbered items in the References at the end of the main text.

** Methods of obtaining and formatting input data are given in Appendix A.

By rearranging terms, the above equation becomes

$$DOS = DI \sqrt{\frac{E}{1.5\ (10^{11})RHO}} \qquad (D1)$$

b. Equation 2. This is the computation of the dynamic pressure impulse (DPI) (graph 2 in Figure D1), and in it the weapon yield input is converted to a weight of 10 metric tons, chosen because it is approximately the middle curve of graph 2.

$$DPI(10^{-5}) = 10 \cdot J\left(\frac{W}{W'}\right)^{1/3} \qquad (D2)$$

where

J = a function of X

$$\begin{aligned} Log_{10}J = & -1.31738 + 27.4602(Log_{10}X) - 75.316(Log_{10}X)^2 \\ & + 98.012(Log_{10}X)^3 - 66.2535(Log_{10}X)^4 \\ & + 22.2579(Log_{10}X)^5 - 2.94354(Log_{10}X)^6 \end{aligned}$$

X = DGZØ, distance from GZ converted to reference case

W = weapon yield input

W' = 10 metric tons

$$DGZ\emptyset - DGZ\left(\frac{W'}{W}\right)^{1/3}$$

where

DGZ = distance from GZ

c. Equation 3. In this operation, the failure point of bending resistance of the tree to DPI at a discrete distance from GZ is calculated. (See vertical scale of graph 6, Figure D1, which is a combination of graphs 3-5.)

$$AKRO = \frac{S(RHO)(4.99)(10^6)}{0.8E(DPI_B)\left[\left(\frac{W}{3.6}\right)^{1/3}(0.75) + \frac{r}{20}\right]} \qquad (D3)$$

where

AKRO = stem failure point at discrete distance from GZ

S = modulus of rupture

RHO = wood density (green)

DPI_B = dynamic pressure impulse converted to reference case

r = radius of input stem

$$DPI_B = DPI\left(\frac{3.6}{W}\right)^{1/3}$$

d. Equations 4-12. These equations were derived to compute tree remnant heights for nine specific tree stem diameters of the reference case, i.e. 6, 8, 12, 16, 20, 30, 40, 60, and 75 cm. The curves for these equations are illustrated on graph 6 in Figure D1. A least-squares method was used in the derivations, and the resultant equations are of the form

$$RH = A_0 + A_1(AKRO) + A_2(AKRO)^2 + \ldots + A_{10}(AKRO)^{10}$$

Table D1 contains the coefficients for all nine equations. If the DOS is within ± 0.5 cm of one of the reference case diameters, the equation for that diameter is used to compute remnant height; otherwise, the equation for the next larger diameter is used. This is a very conservative method, but interpolation is too complicated since the lines on the graph are not related linearly.

3. When the specific strength properties are not available, and the data are classified by wood strengh class, there are instances where some estimated value must be substituted in several of these equations. Each of the six wood strength classes is assigned a strength value corresponding to the term S(RHO)/E in the tree failure equation (Equation D3) and these class values are stored in the program in a variable vector [GRA(N),N = 1,6]. There are six strength classes, and each has a value stored in this vector. Any time it is necessary to use this relation, the associated value is indexed by the strength class value. To obtain the values in this vector, the specific strength

properties for the strongest tree in that class were used. All were obtained from Reference 1.

4. An estimate of DOS must be obtained also, and this is done by assigning the average value of the radical in Equation D1 for trees in each strength class. The specific strength properties are from Reference 1, and the averages for the radical are stored in the program in a variable vector [RADICL(N),N = 1,6]. Again, there are six elements in the vector, one for each of the strength classes. When a value is needed, the proper one is obtained by using the strength class as the index.

5. All the other computations in the program are very simple and require no explanation within the scope of this document. A detailed explanation of this entire nomograph and its use can be found in Reference 27.

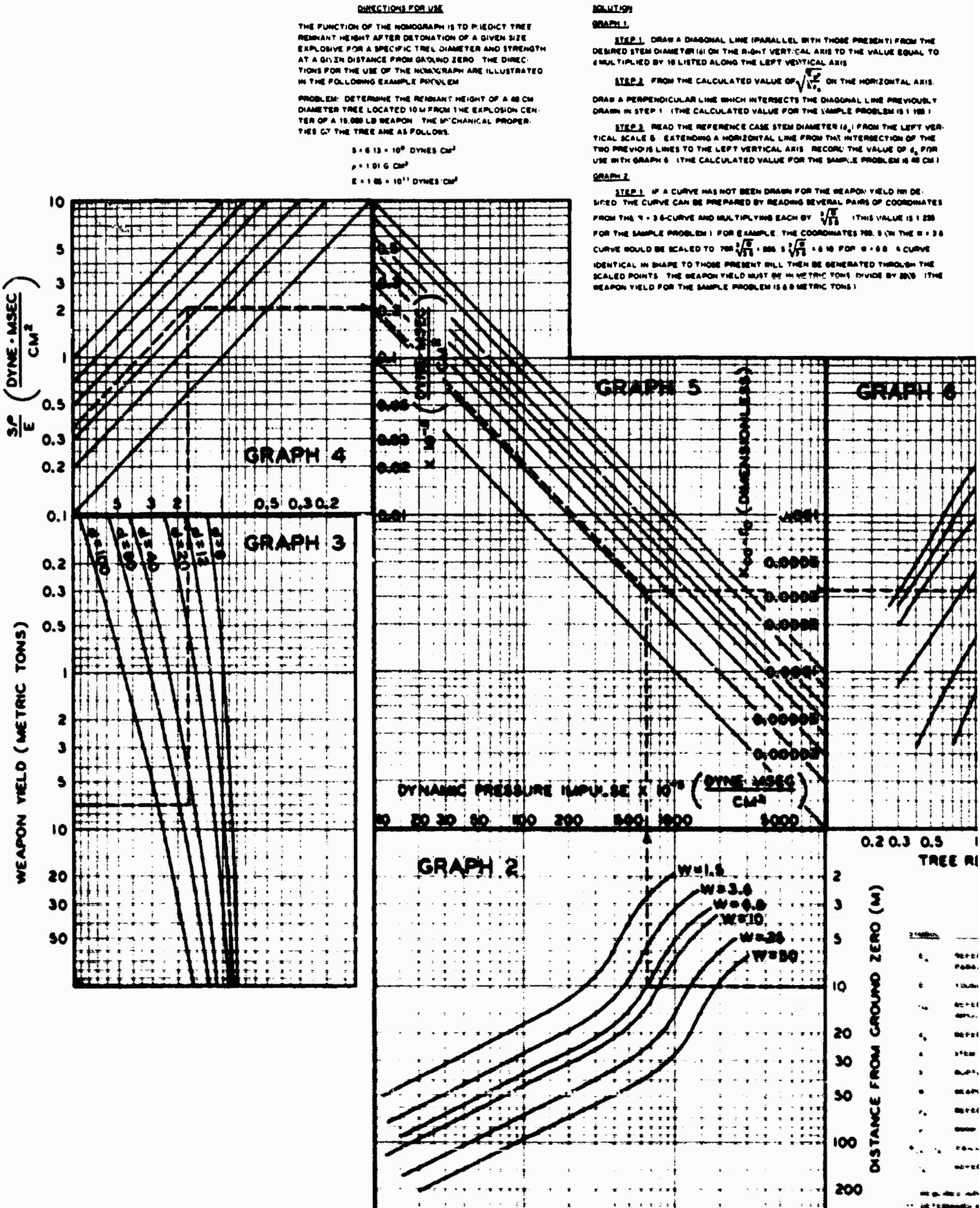


Figure Dl. Calculation of tree remnant height as a function of distance from C

...LLEL WITH THOSE PRESENT) FROM THE ...RTICAL AXIS TO THE VALUE EQUAL TO ...T VERTICAL AXIS

...E OF $\sqrt{\frac{E_{\rho}}{E_{\rho_0}}}$ ON THE HORIZONTAL AXIS ...ECTS THE DIAGONAL LINE PREVIOUSLY ...E FOR THE SAMPLE PROBLEM IS 1.100.)

...STEM DIAMETER (d_0) FROM THE LEFT VER... LINE FROM THE INTERSECTION OF THE ...AL AXIS. RECORD THE VALUE OF d_0 FOR ...UE FOR THE SAMPLE PROBLEM IS 40 CM.)

...RAPH FOR THE WEAPON YIELD (W) BE ...EADING SEVERAL PAIRS OF COORDINATES ...S EACH BY $\sqrt[3]{\frac{W}{3.5}}$ (THIS VALUE IS 1.220 ...E, THE COORDINATES 700, 5 ON THE W = 3.5 ...0, 5 $\sqrt[3]{\frac{W}{3.5}}$ = 6.10 FOR W = 6.6. A CURVE ...LL THEN BE GENERATED THROUGH THE ...E BE IN METRIC TONS, DIVIDE BY 2000. (THE ...IS 6.6 METRIC TONS.)

STEP 2. AT THE POINT WHERE A HORIZONTAL LINE THROUGH THE DESIRED DISTANCE FROM GROUND ZERO CROSSES THE CURVE FOR THE APPROPRIATE WEAPON YIELD, DRAW A VERTICAL LINE THAT EXTENDS ACROSS THE DIAGONAL LINES ON GRAPH 3. (THIS OPERATION WILL YIELD 660 ON THE HORIZONTAL AXIS OF GRAPH 2 FOR THE SAMPLE PROBLEM.)

GRAPH 3.

STEP 1. IF NO CURVE IS PRESENT FOR THE DESIRED STEM DIAMETER (d), AN APPROPRIATE CURVE CAN BE PREPARED BY FINDING HORIZONTAL COORDINATES ASSOCIATED WITH VARIOUS WEAPON YIELDS (W) AS FOLLOWS:

$$F(d,W) = 0.75 + \frac{d}{40\left(\frac{W}{3.5}\right)^{1/3}}$$

THE NUMERICAL VALUES FOR THE HORIZONTAL AXIS ARE PRESENTED ON THE HORIZONTAL AXIS COMMON TO GRAPHS 3 AND 4. IF ONLY ONE WEAPON YIELD IS BEING UTILIZED THE ENTIRE CURVE NEED NOT BE DRAWN UNLESS IT WILL BE USED LATER. (F(d,W) EQUALS 1.72 FOR THE SAMPLE PROBLEM.)

STEP 2. AT THE INTERSECTION OF A HORIZONTAL LINE THROUGH THE GIVEN WEAPON YIELD AND CORRECT STEM DIAMETER CURVE, CONSTRUCT A VERTICAL LINE SO THAT IT PASSES THROUGH THE DIAGONAL LINES ON GRAPH 4.

GRAPH 4.

STEP 1. CONSTRUCT A DIAGONAL LINE (PARALLEL WITH THOSE PRESENT) FROM THE CALCULATED VALUE OF $\frac{SJ_{ko}\rho}{E_{\rho_0}} \times 10^{5}$ ON THE LEFT VERTICAL AXIS. (THE CALCULATED VALUE FOR $\frac{SJ_{ko}\rho}{E_{\rho_0}} \times 10^{5}$ FOR THE SAMPLE PROBLEM IS 8.384.)

STEP 2. FROM THE INTERSECTION OF THE DIAGONAL LINE IN STEP 1 AND THE VERTICAL LINE PROJECTED FROM GRAPH 3, CONSTRUCT A HORIZONTAL LINE WHICH WILL INTERSECT THE RIGHT VERTICAL AXIS OF GRAPH 4. (THIS VALUE IS 0.211 FOR THE SAMPLE PROBLEM.)

GRAPH 5.

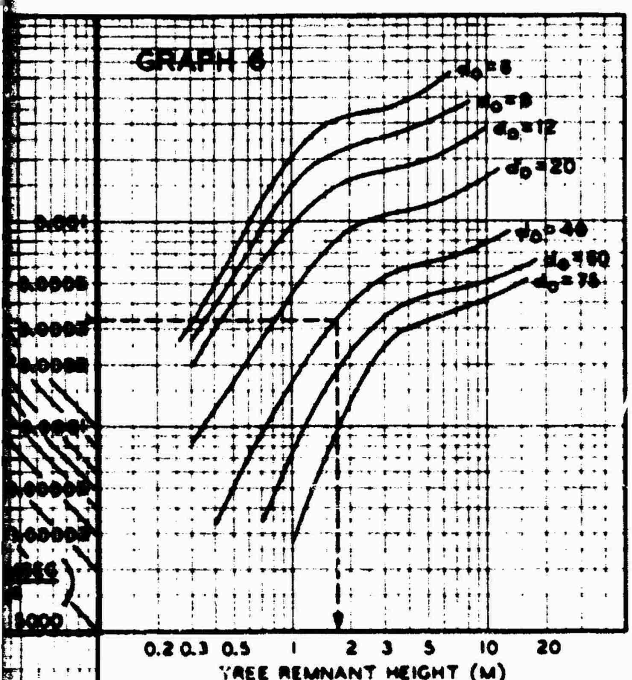
STEP 1. DRAW A DIAGONAL LINE (PARALLEL WITH THOSE PRESENT) FROM THE INTERSECTION POINT ON THE RIGHT VERTICAL AXIS OF GRAPH 4 TO THE POINT ON THE LEFT VERTICAL AXIS OF GRAPH 6 WHOSE VALUE IS SMALLER BY A FACTOR OF 10^{-3}.)

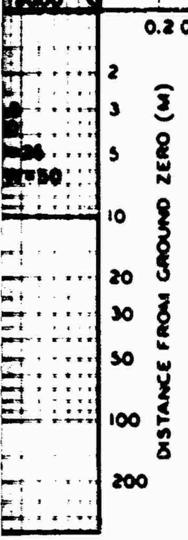
STEP 2. WHERE THE DIAGONAL LINE IN STEP 1 INTERSECTS THE VERTICAL LINE EXTENDING FROM GRAPH 2, CONSTRUCT A HORIZONTAL LINE THROUGH GRAPH 6. (THE VALUE OF THE VERTICAL AXIS OF GRAPH 6 IS 0.0000 FOR THE SAMPLE PROBLEM.)

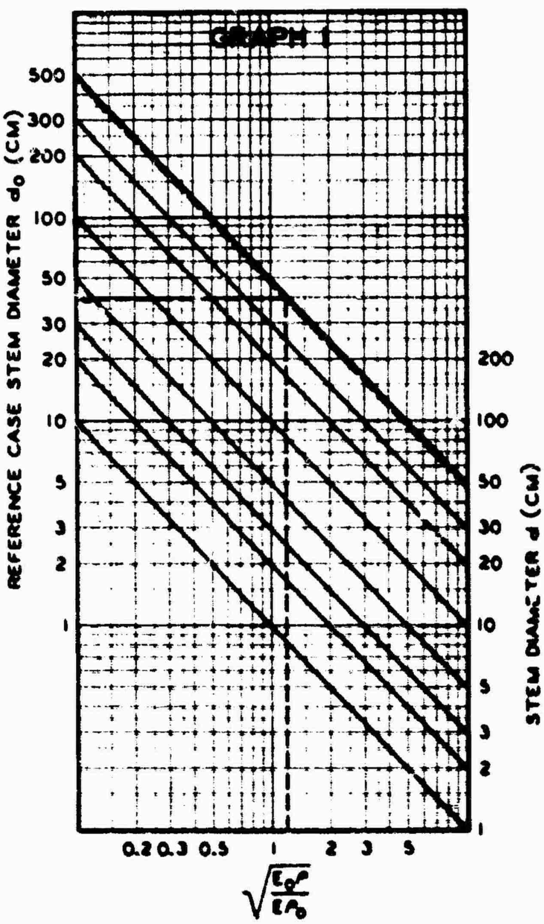
GRAPH 6.

STEP 1. IF NO CURVE EXISTS ON GRAPH 6 FOR THE STEM DIAMETER (d_0) CALCULATED FROM GRAPH 1, ESTIMATE A FEW POINTS IN THE APPROPRIATE INTERVAL FOR THE DIAMETERS GIVEN AND SKETCH THE APPROXIMATE CURVE THROUGH THOSE POINTS CHOSEN.

STEP 2. FROM THE INTERSECTION OF THE K_{ko} ... ρ_0 VALUE HORIZONTAL LINE EXTENDED FROM GRAPH 5 AND THE REFERENCE CASE STEM DIAMETER CURVE, DRAW A LINE WHICH IS PERPENDICULAR TO THE HORIZONTAL AXIS OF GRAPH 6. THE TREE REMNANT HEIGHT IS THE VALUE ASSOCIATED WITH THE POINT AT WHICH THE PERPENDICULAR LINE CROSSES THE HORIZONTAL AXIS. (THE REMNANT HEIGHT IS 1.72 FOR THE SAMPLE PROBLEM.)







LEGEND

[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]

[illegible]

[illegible]

...n of distance from GZ, weapon yield, tree diameter, and tree strength (Reference 27)

Table D1

Coefficients of Remnant Height Equations

DOS	A_0	A_1	A_2	A_3	A_4	A_5	A_6	A_7	A_8	A_9
6	1.29197E-2	1.431743-2	-3.25688E-4	7.49665E-6	-1.04328E-7	6.34473E-10	-3.8673E-12	1.02267E-14	-1.42589E-17	8.11088E-21
8	1.31915E-2	1.78705E-2	-3.728273-4	6.0024E-6	-5.16186E-5	2.28841E-10	-4.81672E-13	3.84085E-16	0	0
12	-4.47209E-2	4.08072E-2	-2.35876E-3	8.90338E-5	-1.89309E-6	2.39103E-8	-1.82047E-10	8.14914E-13	-1.96195E-15	1.95107E-18
16	-6.03898E-2	5.08964E-2	-2.21848E-3	4.65087E-5	-3.0479E-8	-1.21657E-8	1.62239E-10	-1.1657E-12	3.52822E-15	-4.1333E-18
20	-4.13937E-2	6.57575E-2	-3.67793E-3	1.35437E-4	-2.54866E-6	2.45531E-8	-1.12869E-10	1.96718E-13	0	0
30	-1.93081E-2	0.10763	-9.61046E-3	5.27409E-4	-1.43165E-5	1.96952E-7	-1.30119E-9	3.29132E-12	0	0
40	2.22207E-2	0.165895	-1.84391E-2	1.18765E-3	-3.73138E-5	5.917E-7	-4.44791E-9	1.25391E-11	0	0
60	7.37134E-2	0.377174	-0.085736	0.012003	-9.5733E-4	4.56338E-5	-1.31574E-6	2.23663E-8	-2.05042E-10	7.78483E-13
75	0.255214	0.491274	-1.02067	1.1899E-2	-7.01214E-4	2.13806E-5	-3.18534E-7	1.83835E-9	0	0

APPENDIX E: SPECIAL OUTPUT FILES FROM PROGRAM FTJPRH

1. Regardless of which of the three input formats is used, program FTJPRH calls for the establishment of a special file (paragraph 52 in main text) in which calculated remnant height data will be stored. Each such file consists of two sections. The first section (one record) appears in the figure as a single line of data (Figures E1-E3), the configuration of which varies depending upon the input format used to drive the program. In detail, the data are as follows:

Format 1 (Figure E1)

Column numbers	Explanation
1-3	The letters IDR. This symbol indicates an identification record and is invariant
4	Format number code. Thus, a file derived with Format 1 data will always contain a 1 in this column
5-12	Stem diameter in centimetres
13-20	Tree height in metres
21-32	Modulus of rupture in dynes/cm^2, expressed in exponential notation in computer terms
33-44	Young's modulus in dynes/cm^2, expressed in exponential notation in computer terms
45-56	Wood density in g/cm^3, expressed in exponential notation in computer terms

Format 2 (Figure E2)

Column numbers	Explanation
1-3	Identification code IDR
4	Format number code. A file derived from Format 2 data will have a 2 in this column
5-12	Maximum stem diameter in centimetres in the maximum wood strength class
13-20	Maxium tree height in metres in the maximum wood strength class

Format 2 (Figure E2) (Continued)

Column numbers	Explanation
21-28	Maximum wood strength class. The value may range between 1 and 6, inclusive

Format 3 (Figure E3)

Column numbers	Explanation
1-3	Identification code IDR
4	Format number code. A file derived from Format 3 data will always have a 3 in this column
5-12	Maximum stem diameter in centimetres
13-20	Maximum tree height in metres
21-28	Strength class. The value may range between 1 and 6, inclusive.

2. The second section of each file consists of paired numbers, as indicated in Figure E4. It will be noted that the first line indicates that Figure E4 is a record derived from Format 1 data. However, the formats of the files derived from all three input formats are identical after the first line. The first number of the pair is the distance from GZ in metres to the outer edge of an annulus 1 m wide and centered on GZ. The second number of the pair is the height in metres of the tallest remnant in the annulus.

3. The special files described above were included primarily to provide a convenient data store from which graphic plots of the vegetation "crater" could be readily obtained. Such a plot is illustrated in Figure 13 of the main text.

4. The special file produced by program FTJPRH when Formats 2 and 3 are used (Figures E2 and E3) is also essential to the operation of program FTJPHL (see section entitled "Procedure for Estimating Number of Tree Remnants," paragraphs 80-114 of main text).

Column Numbers

Column Numbers	1 2 3	4	5 6 7 8 9 10 11 12	13 14 15 16 17 18 19 20	21 22 23 24 25 26 27 28 29 30 31 32	33 34 35 36 37 38 39 40 41 42 43 44	45 46 47 48 49 50 51 52 53 54 55 56
Field	Identification Record Symbols	Input Format No.	Stem Diameter	Tree Height	Modulus of Rupture	Young's Modulus	Wood Density
Value	I D R	1	10.	5.0	0.310300E 09	0.727470E 11	0.580000E 00

FORMAT: (A3,I1,F8.0,F8.1,3E12.6)

Figure E1. Identification record on output file when Format 1 is used to input vegetation data for program FTJPRH

Column Numbers

1–3	4	5–12	13–20	21–28
Identification Record Symbols	Input Format No.	Maximum Stem Diameter	Maximum Tree Height	Maximum Strength Class
IDR	2	18.	16.0	5

FORMAT: (A3,I1,F8.0,F8.1,I8)

Figure E2. Identification record on output file when Format 2 is used to input vegetation data for program FTJPRH

Column Numbers

1–3	4	5–12	13–20	21–28
Identification Record Symbols	Input Format No.	Maximum Stem Diameter	Maximum Tree Height	Strength Class
IDR	3	8.	2.0	1

FORMAT: (A3,I1,F8.0,F8.1,I8)

Figure E3. Identification record on output file when Format 3 is used to input vegetation data for program FTJPRH

```
IDR1      10.      5.00.310300E 090.727470E 110.580000E 00
        1.0000     0.0001
        2.0000     0.0001
        3.0000     0.2462
        4.0000     0.2940
        5.0000     0.3246
        6.0000     0.3461
        7.0000     0.3643
        8.0000     0.3827
        9.0000     0.4037
       10.0000     0.4284
       11.0000     0.4577
       12.0000     0.4919
       13.0000     0.5311
       14.0000     0.5748
       15.0000     0.6224
       16.0000     0.6733
       17.0000     0.7276
       18.0000     0.7866
       19.0000     0.8526
       20.0000     0.9283
       21.0000     1.0156
       22.0000     1.1138
       23.0000     1.2208
       24.0000     1.3383
       25.0000     1.4837
       26.0000     1.7053
       27.0000     2.0904
       28.0000     2.7458
       29.0000     3.7297
       30.0000     4.9356
       31.0000     5.0000
```

Figure E4. Listing of an output file of program FTJPRH.

APPENDIX F: RATIONALE RELATED TO HELICOPTER LANDING ZONE DESIGN

1. Program FTJPHL requires that the user select a circular or rectangular landing zone design. This option was included because the rectangular zone offers the potential of a significant saving in manual labor and, therefore, time in the preparation of a helicopter landing zone.

Area by Increment

Annular area

2. Because the remnant height-vertical clearance comparison is performed at successive distances from GZ, which is also the geometric center of the landing zone, the number of remnants requiring additional clearing is computed for areas related to GZ by successively larger distances. The simplest method for approaching this concept of area under these conditions is through use of annular increments having radii r_i and $r_i + \Delta r$, where Δr is 2 m for this program and r is 0 at GZ. Figure F1 is an illustration of the area required for a circular landing zone design and how it is composed of annular increments; Figure F2 is a corresponding illustration for a rectangular landing zone design. The two designs share several elements, such as both having a circular area immediately around GZ that is termed the touch zone. It extends out to some radius that is dependent upon the type helicopter used and the mission involved. The two have their geometric centers on GZ and have a 2-m increment in the radii of the annuli. Outside the touch zone the two figures (F1 and F2) differ, and this in turn effects other changes.

3. In Figure F1, the circular design continues to be composed of whole annular increments. This is true since there is no designated wind direction in the circular landing zone, and helicopters can land and take off in any direction. However, Figure F2 shows the rectangular design composed of only those portions of annular increments contained between the parallel boundaries that are a distance of twice the touch zone radius apart. In a rectangular landing zone, there is a designated wind direction running parallel to the two straight-line sides.

Methods used in computing the annular areas outside the touch zone area for the circular design and for the rectangular design are very different.

Equation for circular area

4. For both landing zone designs, the same method is used to compute the incremental areas inside the touch zone. This method is simply the formula for the area of an annulus:

$$A_i = \pi r_i^2 - \pi r_{i-1}^2 \tag{F1}$$

where

A_i = area of a single annulus of increment i

r_i = radius of outer circular edge of annulus

r_{i-1} = radius of inner circular edge of annulus

Number of increments

5. In considering the circular landing zone, Equation F1 is also used to compute the annular areas from the touch zone edge out to some predetermined maximum number of increments, I_{max}, computed by

$$I_{max} = \frac{RTZ + [OH/\tan(DA)]}{DELR} \tag{F2}$$

where

RTZ = radius of touch zone, m

OH = some maximum height for vertical clearance (40 m for this program)

DA = departure angle

DELR = increment length (2 m for this program)

For helicopters that land and take off vertically, a special equation is used. In these instances, the entire landing zone is the touch zone. Therefore, the equation for I_{max} is

$$I_{max} = \frac{RTZ}{DELR}$$

For a graphic illustration of the relation, see Figure F3.

Area of annular segment

6. In considering the incremental areas that lie outside the touch zone for the rectangular design, the process of calculation is much more complicated. Figure F4 is a graphic representation of the derivation of the equation used in the program to compute the incremental areas employed in the rectangular design. It is a method comprising several operations that are related through addition or subtraction. Each is carried out sequentially (1-8) until the section of area of the annulus lying inside the boundary of the landing zone is all that remains. The final step in Figure F4, step 8, is the equation used to compute these incremental areas. The pictorial representation in each step has the area being computed marked by diagonal lines.

7. The maximum number of increments to be processed is I_{max} and is determined by Equation F2.

Computing number of trees to be cleared

8. Each increment of area is processed sequentially. The area of the increment is computed in square metres and, for convenience of handling, is converted to units of 100 m^2. Therefore, when the area of the increment is divided by 100 m^2, the result is the number of units present within the designated increment. To determine the number of trees of a given diameter class and strength class that occur within that designated increment, the number of trees of a given diameter class and strength class per 100 m^2, a value input by the user (Figure 27 in main text), is multiplied by the number of units in the designated increment. From the remnant height-distance from the GZ relation (Figure 7 in main text), the remnant height at a distance equal to the distance from GZ of a point midway between the two radii of the annulus is read establishing a predicted remna height. Because field data have shown that the predicted remnant height is not identical to measured height (Figure F5), the probability that the required vertical clearance is available at the specified distance from GZ must be determined.

9. This is accomplished by dividing the required vertical

clearance by the predicted remnant height to produce a ratio that is analogous to the measured-predicted ratio (Figure F5). The ratio of vertical clearance to predicted remnant height for each increment of area is used as an entry point into the curve in Figure F5 to obtain the percentage of occurrence (or the probability) of the ratio being less than one (see paragraphs 11-15 for more detail about the probabilities). This probability is a measure of the likelihood that the predicted remnant height will exceed the required vertical clearance. When the probability value is multiplied by the number of trees present within the designated increment, the product is the number of trees that will require clearing after the explosion. For any one increment this value is N_i .

10. As each increment is evaluated from first to maximum (I_{max}), the number of trees to be cleared is summed, as

$$\text{Total number of trees to be cleared} = \sum_{i=1}^{I_{max}} N_i$$

This is the prediction of how many trees of a given diameter class within a given strength class would require clearing by pioneer methods.

Obtaining Probability Value

11. The probability value used in the calculation of the number of trees to be cleared is obtained from SUBROUTINE PDF. Each time the subroutine is called, it is entered with a ratio of vertical clearance to remnant height. After this value is examined and the probability of its occurring is obtained, the probability value is returned to the main program to be used in later calculations. The procedure involved in obtaining this probability is the sole function of this subroutine.

12. The probability is obtained in the following way. There are two sets of related data that comprise the entire basis of the subroutine. The first set is a list of possible values the ratio can assume, and the second is a corresponding list of probabilities of

each of those values for the ratio. When entry into the subroutine occurs, a search through the possible ratios is initiated to locate the ratio value carried from the main program. Should that value be equal to one in the list, its position is noted, and the probability value at that same position in the second data set is extracted and returned to the main program. If the value of the ratio is not included in the list of possibilities, the interval in which it is located, between the value just greater and the value just less, is noted, and linear interpolation is performed using the ratio values bounding the interval and their corresponding probabilities. This linearly interpolated value of probability is returned to the main program.

Source of data
<u>for use as probabilities</u>

13. The values filling the data sets can be obtained in several ways. The present information was obtained from a cumulative frequency distribution function derived from a data sample used in the Combat Trap Project,[1*] and several items of information were obtained using the nomograph produced by the project (Figure D1).[27]

<u>Cumulative frequency distribution</u>

14. Data in the sample site were for 292 trees that are listed in the Combat Trap Report.[1] The table contains several items of data including the species, stem diameter, height, etc. After a bomb was detonated in the center of these trees, the height of each remnant was measured and recorded. These remnant heights and other pertinent information, such as type of failure, are also included in that table.

15. In preparing the frequency distribution, some of the 292 trees were eliminated for such reasons as only stem failures are applicable, the tree was somehow defective, etc. The number of trees used was reduced to 218. The measured remnant heights of these were taken from that table, and then, using the nomograph (Figure D1), a remnant height for each stem was predicted. All this information is included

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* Raised numerals refer to similarly numbered items in the References at the end of the main text.

in Table F1. The value that was to be distributed was a ratio of measured remnant height to predicted height; therefore, this ratio was computed and is also included in Table F1. The distribution of the ratios is a measure of how often the actual remnant height exceeds the one predicted using the nomograph.

16. After all the ratios were computed, they had to be arranged sequentially, the number of occurrences of each recorded, and the percentage of all occurrences calculated. This was done using accumulative sums, thereby producing a cumulative frequency distribution which, when plotted, is the curve in Figure F5. Since no equation was easily fitted to the data, the values for possible ratios and their corresponding percentage of occurrence included in Table F1 were used as the two data sets in SUBROUTINE PDF. Since the spread between the ratio values is so small, linear interpolation between points is acceptable.

Statistical validity

17. It is recognized that this curve is not a probability density function and that these data are not statistically valid for the probabilities. It is, however, one sample that is empirical; if time permitted, the procedure used in obtaining this single distribution could be repeated on other samples until the point was reached at which the data were representative of statistically valid information. That information could then be substituted in SUBROUTINE PDF. The procedures used in program FTJPHL would not have to be altered.

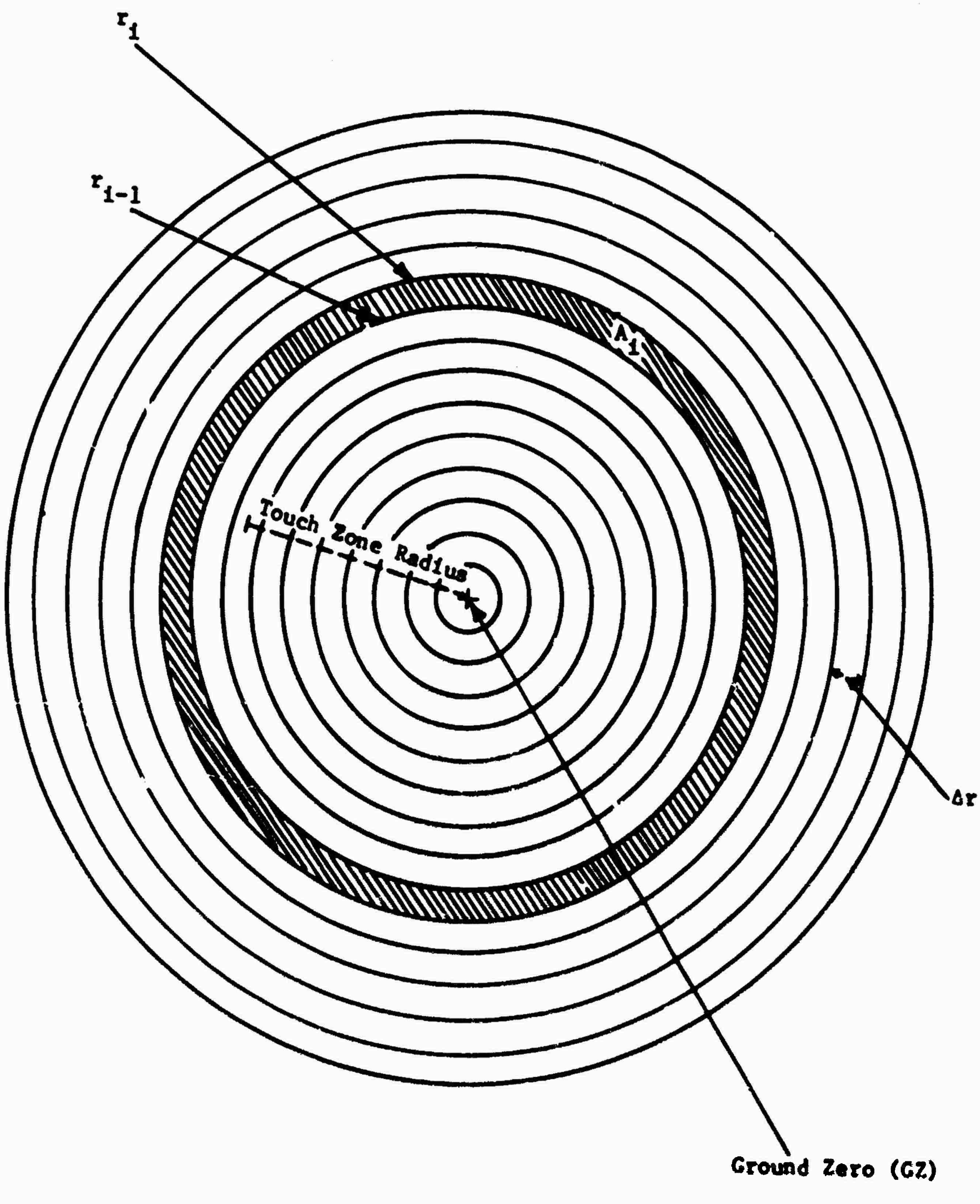


Figure F1. Illustration of area increments for circular landing zone design

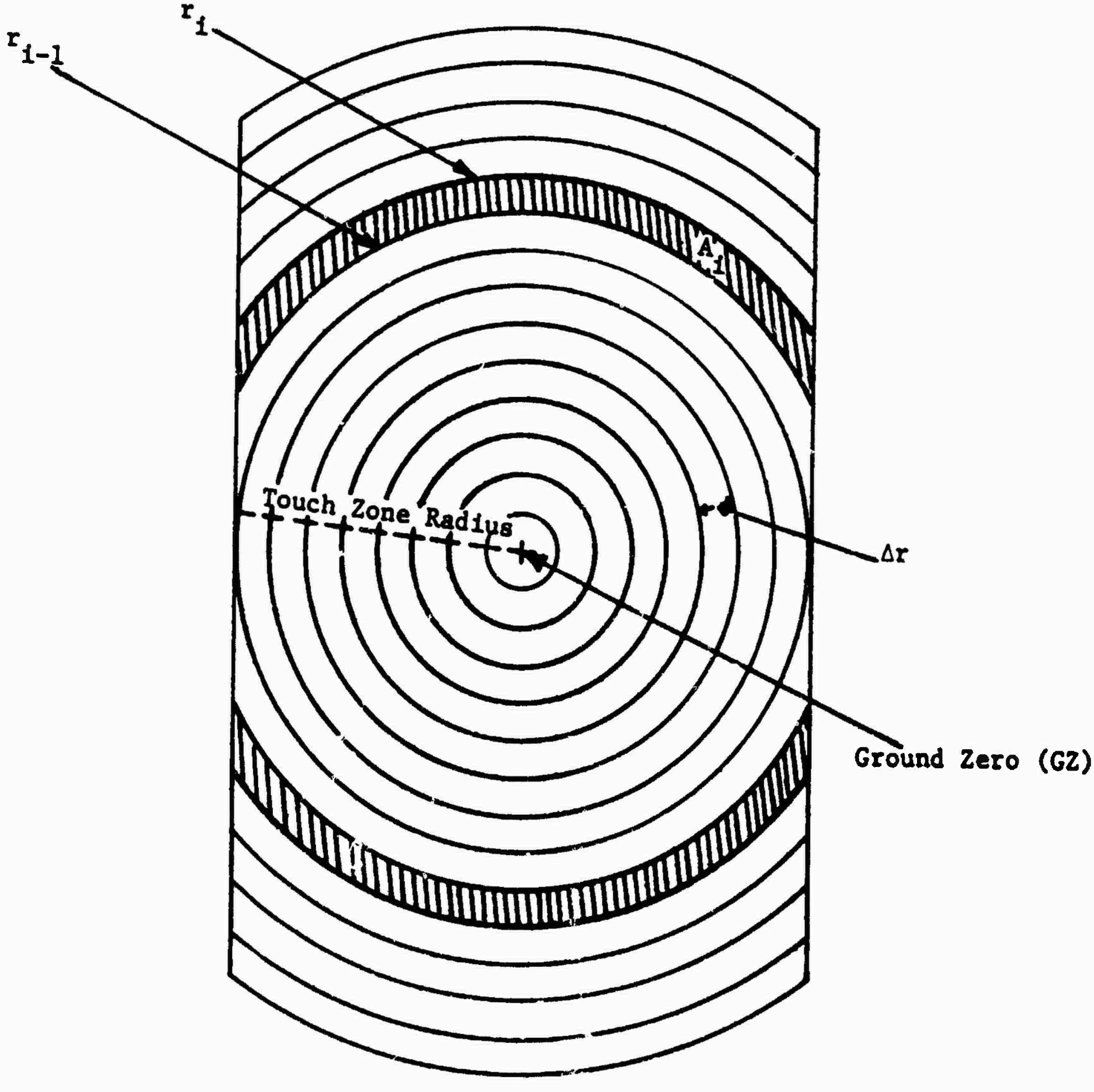
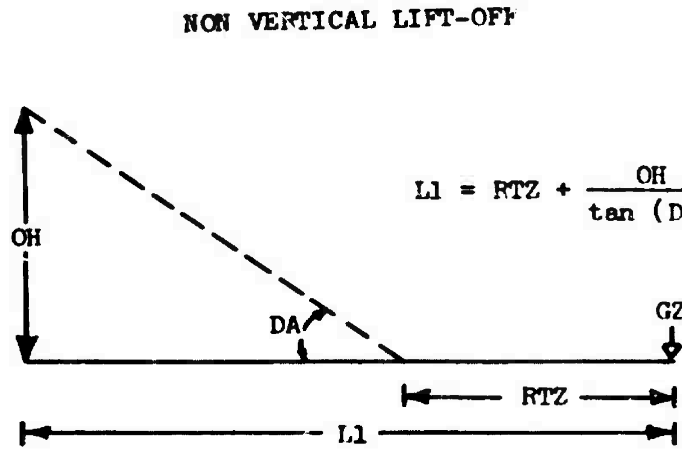
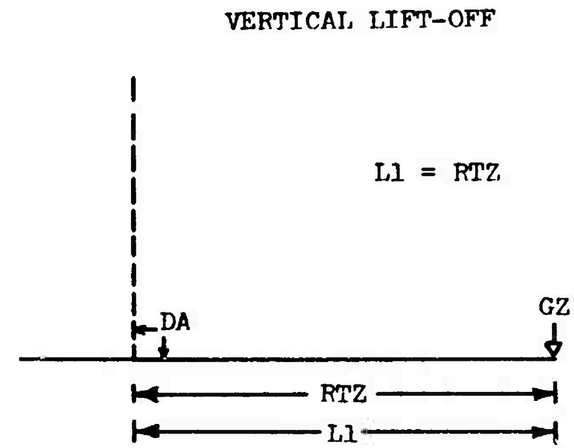


Figure F2. Illustration of area increments for rectangular landing zone design



$$L1 = RTZ + \frac{OH}{\tan(DA)}$$



$$L1 = RTZ$$

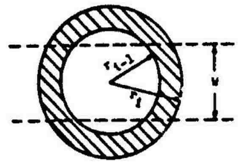
RTZ	Radius of touch zone
GZ	Ground zero (center of landing zone)
DA	Departure angle
OH	Height of obstacle to be cleared (maximum value of 40m)
L1	Length of half of landing zone

$$I_{max} = \frac{L1}{DELR}$$

I_{max}	Number of increments (only integer portion used)
DELR	Increment length (2m in this program)

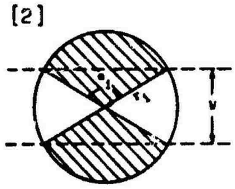
Figure F3. Graphic illustration of computation of number of increments to be included in calculation of landing zone design

[1]



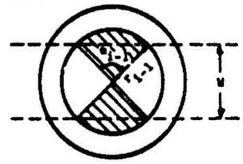
$$A_{it} = \pi r_i^2 - \pi r_{i-1}^2 = \pi(r_i + r_{i-1})(r_i - r_{i-1})$$

[2]



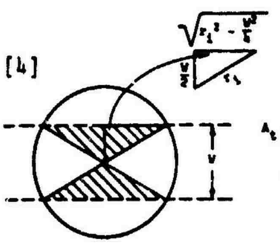
$$A_{si} = 2\left(\frac{1}{2} r_i^2 \theta_i\right) = r_i^2 \theta_i$$

[3]



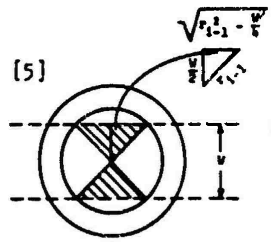
$$A_{s(i-1)} = 2\left(\frac{1}{2} r_{i-1}^2 \theta_{i-1}\right) = r_{i-1}^2 \theta_{i-1}$$

[4]



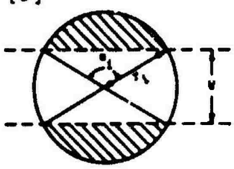
$$A_t = 4\left[\left(\frac{1}{2}\right)\left(\frac{W}{2}\right)\sqrt{r_i^2 - \frac{W^2}{4}}\right] = W\sqrt{r_i^2 - \frac{W^2}{4}}$$

[5]



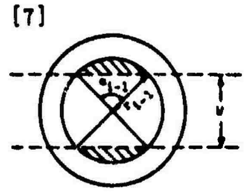
$$A_{t(i-1)} = 4\left[\left(\frac{1}{2}\right)\left(\frac{W}{2}\right)\sqrt{r_{i-1}^2 - \frac{W^2}{4}}\right] = W\sqrt{r_{i-1}^2 - \frac{W^2}{4}}$$

[6]



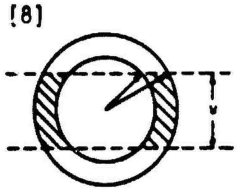
$$A_{ie} = A_{si} - A_t = r_i^2 \theta_i - W\sqrt{r_i^2 - \frac{W^2}{4}}$$

[7]



$$A_{(i-1)e} = A_{s(i-1)} - A_{t(i-1)} = r_{i-1}^2 \theta_{i-1} - W\sqrt{r_{i-1}^2 - \frac{W^2}{4}}$$

[8]



$$A_i = A_{it} - \left[A_{ie} - A_{(i-1)e}\right] = \pi(r_i - r_{i-1})(r_i + r_{i-1}) - \left[r_i^2\theta_i - r_{i-1}^2\theta_{i-1} + W\left(\sqrt{r_{i-1}^2 - \frac{W^2}{4}} - \sqrt{r_i^2 - \frac{W^2}{4}}\right)\right]$$

Figure F4. Steps to follow in computing the area of a section of annulus (radii r_i and r_{i-1}) included between two parallel boundary lines (distance of W apart) of the rectangular landing zone design

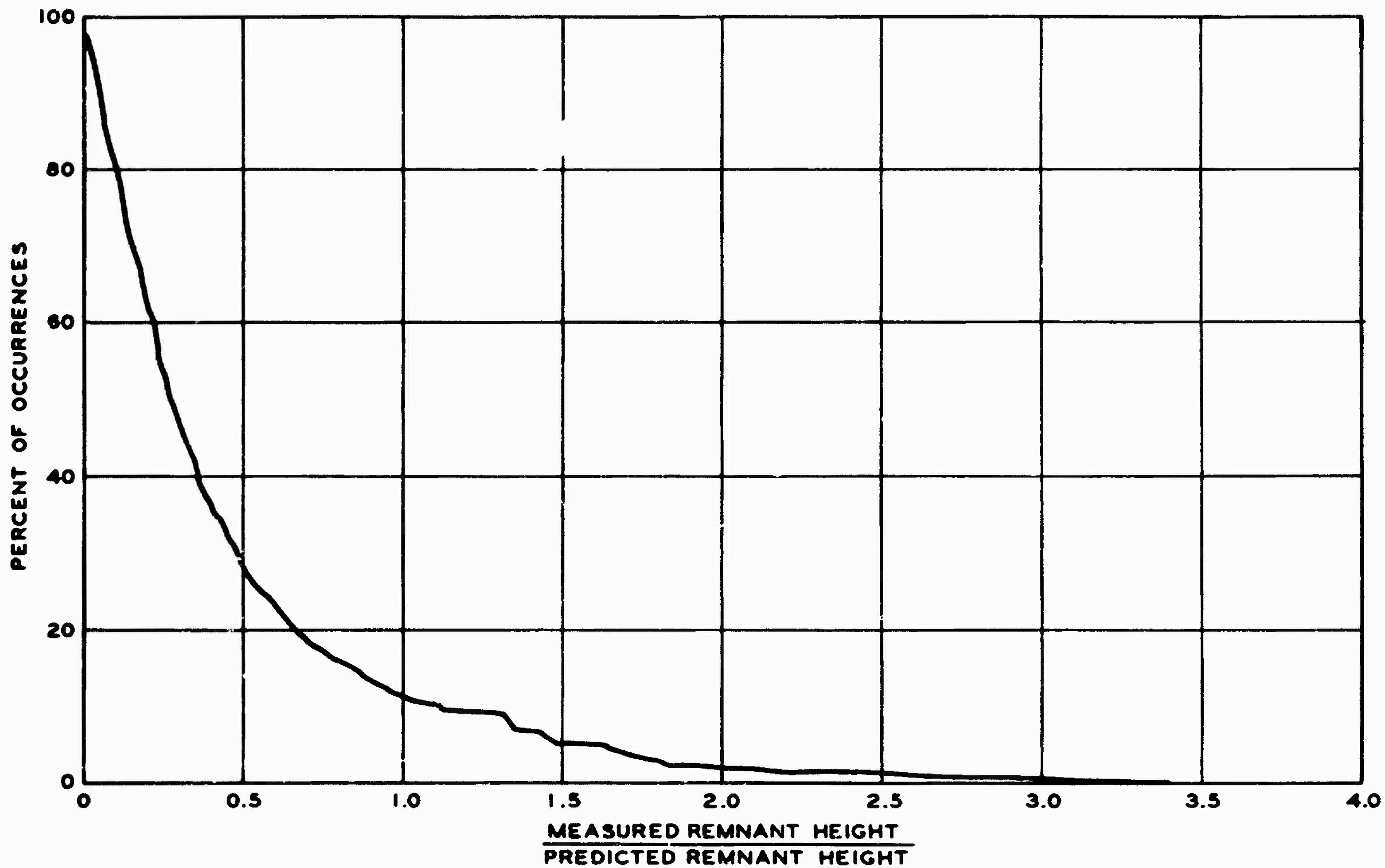


Figure F3. Cumulative frequency distribution of ratios of measured remnant height to predicted remnant height in a sample of 218 stems into which a 15,000-lb bomb was dropped

Table F1

Measured and Predicted Remnant Heights of 218 Stems in Sample Used to Derive the Cumulative Distribution Function in SUBROUTINE PDF

Tree No.	Measured Remnant Height (MRH), m	Predicted Remnant Height (PRH), m	MRH/PRH	Tree No.	Measured Remnant Height (MRH), m	Predicted Remnant Height (PRH), m	MRH/PRH
1	7	39	0.18	63	667	3000	0.22
2	100	130	0.77	64	450	400	1.13
3	18	71	0.25	65	540	400	1.35
6	45	64	0.70	66	65	147	0.44
7	70	84	0.83	67	320	650	0.49
9	7	64	0.11	69	793	3000	0.26
11	84	130	0.65	70	302	1500	0.20
12	178	160	1.11	71	205	1950	0.11
13	65	1100	0.06	72	954	3250	0.29
16	353	400	0.88	73	265	2000	0.13
17	250	120	2.08	74	170	360	0.47
18	624	230	2.71	75	200	1150	0.17
19	220	153	1.44	76	0	630	0.00
20	280	148	1.89	77	385	3050	0.13
21	10	140	0.07	79	50	58	0.86
22	190	130	1.46	80	42	142	0.30
23	142	150	0.95	81	55	420	0.13
24	370	710	0.52	82	142	180	0.79
26	14	640	0.02	83	120	450	0.27
27	841	3300	0.25	84	729	3200	0.23
28	390	1000	0.39	85	160	1500	0.11
30	45	700	0.06	86	35	650	0.05
31	30	650	0.05	87	378	1750	0.22
32	118	900	0.13	89	24	1650	0.01
38	12	200	0.06	91	595	400	1.49
39	4	120	0.03	93	320	1950	0.16
40	15	66	0.23	95	30	83	0.36
45	86	125	0.69	96	150	91	1.65
46	86	85	1.01	97	10	78	0.13
48	130	440	0.30	98	87	125	0.70
49	100	75	1.33	99	105	163	0.64
51	292	160	1.83	100	40	110	0.36
52	295	720	0.41	101	210	128	1.64
53	255	720	0.35	102	663	1000	0.66
54	759	3200	0.24	103	385	420	0.92
55	680	3600	0.19	106	5	56	0.09
57	400	1140	0.35	107	50	103	0.49
59	159	420	0.38	108	203	152	1.34
60	400	300	1.33	109	40	88	0.45
62	205	1200	0.17	110	19	270	0.07

(Continued)

Table F1 (Continued)

Tree No.	Measured Remnant Height (MRH), m	Predicted Remnant Height (PRH), m	MRH/PRH	Tree No.	Measured Remnant Height (MRH), m	Predicted Remnant Height (PRH), m	MRH/PRH
111	25	112	0.22	158	170	520	0.33
112	75	76	0.99	159	285	560	0.51
113	170	165	1.03	160	683	3000	0.23
114	0	123	0.00	161	125	130	0.96
115	112	340	0.33	165	55	86	0.64
116	205	540	0.38	166	561	165	3.40
117	100	950	0.11	167	500	2800	0.18
118	498	2100	0.24	168	180	3100	0.06
119	230	1000	0.23	170	113	230	0.49
122	75	900	0.08	172	18	128	0.14
123	255	760	0.34	173	50	125	0.40
124	20	1150	0.02	174	110	130	0.85
126	487	270	1.80	175	335	200	1.68
127	15	133	0.11	177	10	124	0.08
128	25	162	0.15	178	170	1000	0.17
129	25	520	0.05	179	60	380	0.16
130	355	140	2.54	180	200	380	0.53
131	160	800	0.20	181	280	780	0.36
132	120	1000	0.12	183	295	2250	0.13
133	255	900	0.28	184	145	2250	0.06
134	235	1850	0.13	185	20	900	0.02
135	780	2900	0.27	186	514	1900	0.27
136	20	94	0.21	187	240	1350	0.18
138	200	152	1.32	189	270	1150	0.23
140	0	67	0.00	190	942	3000	0.31
142	15	128	0.12	191	505	2600	0.19
143	43	90	0.48	192	927	2600	0.36
145	50	1250	0.04	194	300	600	0.50
146	625	2050	0.30	195	165	2450	0.07
147	460	2250	0.20	196	50	1200	0.04
148	684	1100	0.62	197	55	155	0.35
149	40	650	0.06	198	200	260	0.77
150	911	2500	0.36	199	25	920	0.03
151	70	2100	0.03	200	40	97	0.41
152	140	1100	0.13	201	35	128	0.27
153	235	1100	0.21	202	90	63	1.43
154	154	1250	0.12	203	19	53	0.36
155	649	2900	0.22	204	97	168	0.58
156	375	840	0.45	206	35	150	0.23
157	120	590	0.20	207	170	300	0.57

(Continued)

Table F1 (Concluded)

Tree No.	Measured Remnant Height (MRH), m	Predicted Remnant Height (PRH), m	MRH/PRH	Tree No.	Measured Remnant Height (MRH), m	Predicted Remnant Height (PRH), m	MRH/PRH
208	450	900	0.50	261	235	2800	0.08
209	230	1300	0.18	262	435	2850	0.15
210	230	2650	0.09	263	2563	2950	0.87
211	220	1700	0.13	265	200	1450	0.14
212	562	600	0.94	269	450	2000	0.23
213	120	1250	0.10	271	1086	1900	0.57
214	712	2550	0.28	272	1096	1800	0.61
215	475	700	0.68	273	1074	2100	0.51
216	340	2300	0.15	274	5	300	0.02
218	285	1150	0.25	275	955	2350	0.41
219	670	900	0.74	278	906	1600	0.57
220	75	250	0.30	279	65	950	0.07
221	285	120	2.38	280	105	1150	0.09
222	125	440	0.28	281	22	550	0.04
223	270	420	0.64	285	64	900	0.07
225	862	2800	0.31	286	922	2800	0.33
226	385	500	0.77	287	926	2600	0.36
229	90	145	0.62	290	300	2850	0.11
230	635	2000	0.32				
231	175	1800	0.10				
233	828	2900	0.29				
234	70	1000	0.07				
235	605	350	1.73				
236	0	64	0.00				
238	771	1800	0.43				
239	488	1050	0.46				
240	919	2850	0.32				
241	1362	3000	0.45				
242	170	2450	0.07				
243	1199	2550	0.47				
244	1145	1850	0.62				
246	117	620	0.19				
247	999	2450	0.41				
249	445	2500	0.18				
251	100	1100	0.09				
252	615	3100	0.20				
253	489	3100	0.16				
256	100	2250	0.04				
258	1136	2500	0.45				
260	0	1300	0.00				

(Sheet 3 of 3)

In accordance with ER 70-2-3, paragraph 6c(1)(b), dated 15 February 1973, a facsimile catalog card in Library of Congress format is reproduced below.

Parks, Judith A

Automated procedure for evaluating sites for suitability as helicopter landing zones, by Judith A. Parks. Vicksburg, U. S. Army Engineer Waterways Experiment Station, 1976.

2 v. illus. 27 cm. (U. S. Waterways Experiment Station. Instruction report M-76-1)

Prepared for Office, Chief of Engineers, U. S. Army, Washington, D. C., and U. S. Army Materiel Development and Readiness Command, Alexandria, Virginia, under Project No. 4A162121AT31, Task 02, Work Unit 02, and No. 1T162112A528, Task 02, Work Unit 02.

Contents.-v.1. Descriptions and instructions for use of computer programs.-v.2. Listings of computer programs.

1. Aircraft landing areas. 2. Computer programs. 3. Helicopter landing zones. 4. Mathematical models. 5. Site selection. I. U. S. Army. Corps of Engineers. II. U. S. Army Materiel Development and Readiness Command. (Series: U. S. Waterways Experiment Station, Vicksburg, Miss. Instruction report M-76-1)

TA7.W34i no.M-76-1